TREASURY DEPARTMENT
United States Public Health Service

HYGIENIC LABORATORY—BULLETIN No. 89
MAY, 1913

SEWAGE POLLUTION OF INTERSTATE AND INTERNATIONAL WATERS

WITH SPECIAL REFERENCE TO THE SPREAD OF TYPHOID FEVER

VI. THE MISSOURI RIVER FROM SIOUX CITY TO ITS MOUTH

By

ALLAN J. McLAUGHLIN

WASHINGTON
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SEWAGE POLLUTION OF INTERSTATE AND INTERNATIONAL WATERS WITH SPECIAL REFERENCE TO THE SPREAD OF TYPHOID FEVER.

INTRODUCTION.

The disastrous results of sewage pollution of interstate and international water supplies have been fully discussed in former bulletins covering the drainage area of the Great Lakes. These bulletins further discussed the excessive prevalence of typhoid fever in the United States, the relation of typhoid fever to polluted water supplies, and the remedies which would be applicable to the correction of our sanitary defects. In order to avoid repetition, these and other subjects discussed in detail in Hygienic Laboratory Bulletins 77 and 83 are omitted here.

The study of the Missouri River was begun upon the request of Dr. S. J. Crumbine, secretary of the State Board of Health of Kansas. The sanitary authorities of Kansas, Nebraska, Missouri, and Iowa had considered with apprehension the rapidly growing pollution of this great interstate waterway. Some effort was made to secure joint action by the States interested, and several meetings were held and resolutions passed. In 1911 the Surgeon General, Public Health Service, was requested to detail an officer to cooperate with a commission appointed by the governor of Kansas in a sanitary survey of the river. The writer was detailed, and began work in April, 1912.

It was deemed wise to attempt to secure the cooperation of various forces, State boards of health, State universities, and municipal boards of health. This was especially desirable because of the limitation of the Federal appropriations, which precluded any large expenditure of money by the Public Health Service.

The cooperation secured is evidence of the public-spirited attitude of the officials and their willingness to assist in such a work, even at considerable personal sacrifice. The demonstration that municipal, State, and Federal officers can work harmoniously is in itself an object lesson of value, showing what may be accomplished by such cooperation at a very low cost.

Obviously, the most important part of the river from the standpoint of sewage pollution was that portion from Sioux City to its mouth, and it was decided to confine these first studies to this part of the watershed.

MAP 1.—Watershed of the lower Missouri River showing sewered towns and sampling stations.

The cooperative plan outlined was as follows: First, a sanitary survey of the important cities and towns on the river; second, examinations of samples of the water of the river taken daily for a period of at least two months, the sampling points to be fixed above and below the principal sources of pollution and in the mouths of tributaries. In order that the results might have comparative value it was deemed wise to have the examinations made simultaneously over the entire area. The advisability of a long series was appreciated, but there were insuperable difficulties in the way of securing examinations for a longer period than two months. Inasmuch as a year's daily examinations were not feasible the months of June and July were selected. These months have certain advantages in the Missouri Valley, including a period of very high water with probably the maximum pollution, as evidenced by bacterial counts.

The following is a list of the laboratories, the names of the officials extending the courtesies of these laboratories, the names of the bacteriologists who did the work, and the points from which samples were taken:

Name of laboratory.	Sampling points.	Officials extending the courtesy.	Bacteriologist.
Bacteriological laboratory, Iowa State Board of Health, Iowa City, Iowa.	(1) Missouri River, Sioux City, Iowa, below city sewers.	Dr. G. H. Sumner, secretary State board of health; Prof. Henry Albert, director of laboratory.	Prof. Albert.
Laboratory of Omaha city department of health.	(2) Missouri River above city's sewers; (3) Missouri River below city's sewers.	Dr. Ralph W. Connell, commissioner of health.	Dr. Millard Langfeld.
University of Nebraska department of bacteriology.	(4) Missouri River at Plattsmouth; (5) Platte River at Plattsmouth.	Dr. E. Arthur Carr, secretary Nebraska State Board of Health; Prof. H. H. Waite, University of Nebraska.	Prof. Waite; Mr. John J. Putnam.
Laboratory of city of St. Joseph.	(6) Missouri River above city; (7) Missouri River below city; (8) Missouri River below packing plants.	Col. J. A. Corby, president board of health.	Dr. E. A. Logan.
Water and sewage laboratory, State board of health, University of Kansas, Lawrence, Kans.	(9) Atchison, above city; (10) Atchison, below city; (11) Leavenworth, above city; (12) Leavenworth, below city; (13) Kansas River at Lawrence; (14) Kansas River at Bonner Springs; (15) Kansas River at Kansas City.	Dr. S. J. Crumbine, secretary State board of health.	Prof. Sherwood; Prof. Young; Miss Greenfield.
Laboratory department of health, city of Kansas City, Mo.	(16) Kansas River at Kansas City; (17) Missouri River above mouth of Kansas River; (18) Missouri River below Kansas City sewers; (19) Missouri River at Independence, Mo.	Dr. W. S. Wheeler, commissioner of health; Dr. H. Delamater, assistant commissioner of health.	Dr. J. R. Vanatta.
Bacteriological laboratory, Missouri State Board of Health.	(20) Missouri River at Jefferson City, Mo.	Dr. Ernest F. Robinson, president State board of health; Dr. Frank B. Hiller, secretary State board of health.	Dr. Murray C. Stone.

In the collection and shipping of samples other public-spirited individuals assisted very greatly. Each laboratory received and examined daily samples from one or more sampling points.

Dr. Delamater furnished the containers and supervised the collection of samples at Kansas City, Mo. The State Board of Health of Kansas furnished containers for the collection of samples at Lawrence, Bonner Springs, Kansas City, Kans., Leavenworth, and Atchison, and the collection and shipment of samples were supervised by the local officials. The interest and cooperation, involving personal sacrifice, evidenced by Dr. McKee, of Leavenworth, Kans., and Dr. F. L. Cook, of Independence, Mo., were especially noteworthy. Dr. Murray C. Stone collected the samples at Jefferson City, Mo. The collection of samples at St. Joseph, Mo., was made possible through the hearty cooperation of Col. J. A. Corby, president of the board of health. Dr. E. Arthur Carr, secretary State Board of Health of Nebraska, arranged for collection, shipment, and examination of two samples daily from Plattsmouth.

Dr. Ralph W. Connell, commissioner of health, Omaha, Nebr., took a personal interest in the work and secured the collection and examination of two samples daily at Omaha. The Iowa State Board of Health agreed to examine one sample daily from Sioux City, and Dr. E. W. Meis, of Sioux City, supervised the collection and shipment of the sample.

The examination of samples was made in the laboratories listed above, and the writer feels indebted not only officially but personally to the bacteriologists who gave their time to this work and whose only compensation was the assurance that they were doing something for the general welfare.

In order to secure uniformity of procedure simple rules were agreed to and followed by the various workers. The samples were packed in ice for shipment, and although in some instances this was unnecessary, it was deemed best to make no exception, even if the time of transit from sampling point to laboratory was short.

It was decided to have the examinations cover total bacterial counts and quantitative B. coli estimations; the total bacterial counts to be made on agar plates grown at 37° C.; the B. coli tests to be made as follows:

Each sample was planted in lactose bouillon fermentation tubes, using dilutions of 10 c. c., 1 c. c., 0.1 c. c., 0.01 c. c., 0.001 c. c., etc., in order to secure a + and − in each set of four or five dilutions. The fermentation tubes were incubated 48 hours at 37° C. The B. coli tests were not carried beyond the isolation of typical B. coli colonies on litmus lactose agar plates. The amount of gas was not considered, but all tubes showing gas were plated and the combination of gas + the typical B. coli colony on litmus lactose agar was recorded as positive for B. coli. The observations of Frost [1] and other workers show that the index of error in such a calculation is not great, and that probably more than 95 per cent of such colonies are sewage bacteria of the Colon type.

The use of agar instead of gelatin, of litmus lactose agar plates instead of Endo's medium, and lactose bouillon instead of lactose bile was determined by considerations of expediency and not because these media were considered superior. In a cooperative work of this character, it was essential to select the methods which imposed the least possible additional work and which workers would carry out most uniformly.

The results of the laboratory work were collected from the workers by Passed Asst. Surg. John S. Boggess,[2] and the interpretation of these results made in Washington. The total bacterial counts were averaged by months, and the B. coli content was estimated according to the method of Phelps.[3] This method is simple, and, for comparative purposes on the same stream, is sufficiently accurate when a large number of examinations are made. It gives us in the monthly averages an index of the relative amount of pollution at various points in the river.

THE DRAINAGE AREA OF THE LOWER MISSOURI.

PRINCIPAL SOURCES OF POLLUTION.

The drainage area tributary to the lower Missouri River includes practically the entire State of Nebraska, the western third of Iowa, the northern half of Kansas, and a large part of the State of Missouri.

In a study of pollution of the lower Missouri River certain facts are prominent as having an important bearing on the subject. First, the character of the rural districts is such that considerable animal pollution is certain to reach the streams; second, the population per square mile is not excessive, and in many of the rural districts is decreasing; third, very significant pollution comes from the large cities, and the population of these cities is increasing.

State.	Persons to square mile.	Rural population per square mile.	Decennial per cent increase of population, 1900–1910.	
			Urban.	Rural.
Nebraska	15.5	11.5	18.7	+9.6
Iowa	40.0	27.8	19.9	−7.2
Kansas	20.7	14.6	39.0	+7.3
Missouri	47.9	27.6	22.3	−3.5

[1] Frost, W. H.: Hygienic Lab. Bull. No. 78, U. S. Public Health Service, p. 117.

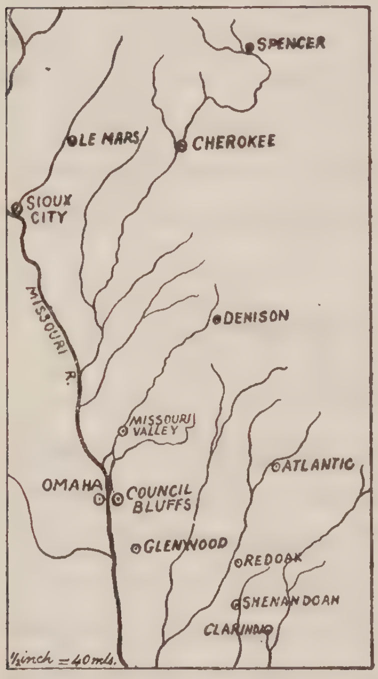
[2] Passed Asst. Surg. Boggess also arranged for collection and examination of the samples at Sioux City and of the two samples at Plattsmouth. The writer wishes to express his indebtedness to Dr. Boggess for his assistance.

[3] Phelps, Earle B.: A method for calculating the number of B. coli from the results of dilution tests. Reports and papers of the American Public Health Association, vol. 33, 1907, pt. 2, pp. 9–13.

The rural population in Iowa and Missouri has reached beyond 27 persons to the square mile and is now decreasing. The rural population in Kansas and Nebraska is only 14.6 and 11.5 respectively; hence, the slight increase in rural population is to be expected. It may be accepted, judging by the experience of older States, that the rural population per square mile will not exceed 30, certainly not for many years.

The large rural population with the great number of domestic animals is sufficient to contribute to the streams draining this area a considerable degree of pollution, especially when heavy rains and thaws wash the surface pollution into the streams.

This rural pollution may be accepted as inevitable. On the other hand, the pollution of the streams from urban sources is very great, is constantly increasing, is susceptible of control, and should be very carefully controlled.



Map 2.—Missouri River drainage area in Iowa showing sewered towns.

In addition to the pollution of the Missouri River by rural communities, there is a certain amount of pollution from tributary streams receiving sewage from cities or towns of less than 5,000 population. If these towns are situated at considerable distances from the main river, they may be considered in the same category as rural pollution, because of the effect of stream flow on the small amount of sewage contributed. Besides the rural pollution and distant pollution from these small cities, there remains to be considered the most important class of contributors to the pollution of the Missouri, viz, the large cities. Some of these cities are growing rapidly, and in addition to the sewage, have packing plants which discharge large quantities of wastes into the Kansas and Missouri Rivers.

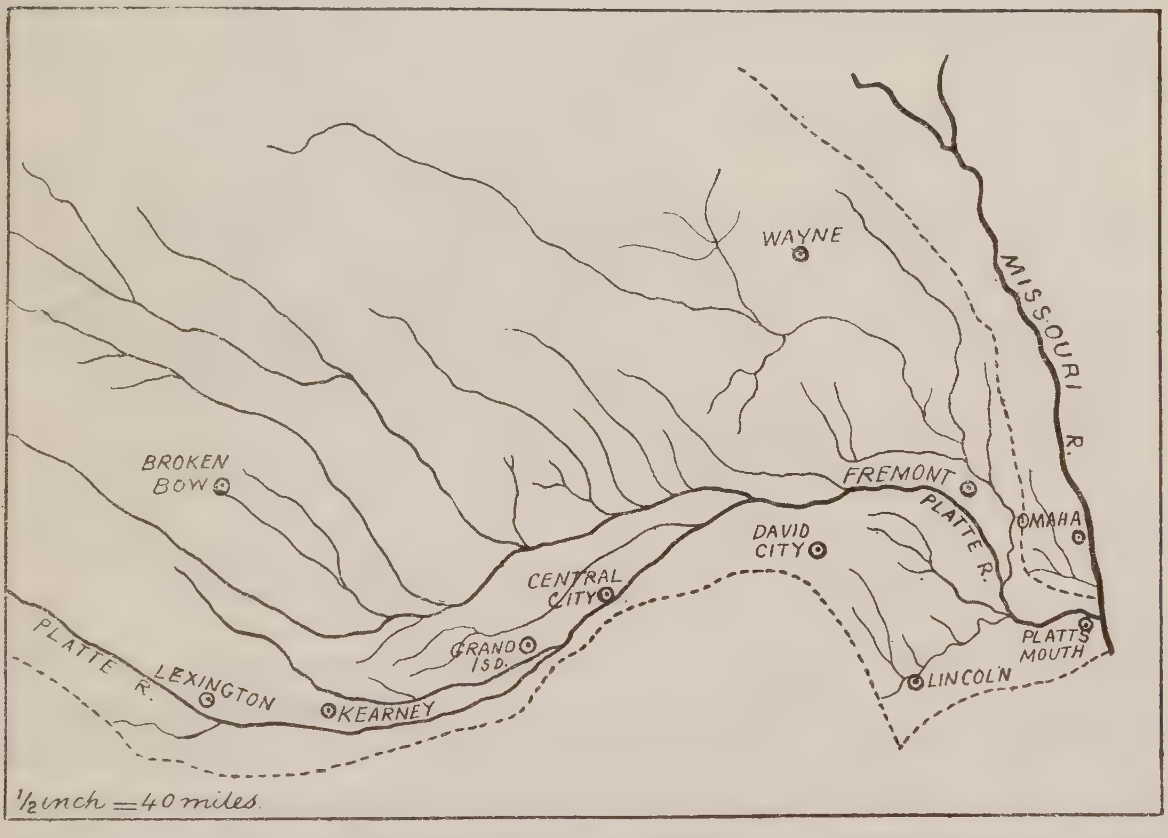
Map No. 2 shows the urban population in Iowa which is tributary to the Missouri River above Kansas City. The distances from the Missouri River and populations are as follows:

City, town, or village.	Population, 1910.	Approximate distance from Missouri River.	City, town, or village.	Population 1910.	Approximate distance from Missouri River.
		Miles.			*Miles.*
Le Mars	4,157	25	Missouri Valley	3,187	20
Cherokee	4,884	75	Atlantic	4,560	90
Sheldon	2,941	55	Glenwood	4,052	15
Spencer	3,005	125	Red Oak	4,830	60
Sioux City	47,828	....	Clarinda	3,832	60
Council Bluffs	29,292	....	Shenandoah	4,976	60
Denison	3,133	50			

On the Nebraska side of the Missouri there is practically no urban pollution between Sioux City and Omaha. The Platte River drains a very large territory, but its urban population is small, and considerable distances intervene between these cities and the Missouri River.

Map No. 3 shows the Platte River with towns of over 2,000. The urban population and distances from the Missouri are as follows:

City, town, or village.	Population, 1910.	Approximate distance from Missouri River.	City, town, or village.	Population, 1910.	Approximate distance from Missouri River.
		Miles.			*Miles.*
Broken Bow	2,260	215	David City	2,177	70
Lexington	2,059	215	Wayne	2,140	125
Kearney	6,202	199	Fremont	8,718	50
Grand Island	10,326	150	Lincoln	43,973	45
Central City	2,428	125	Plattsmouth	4,287	0



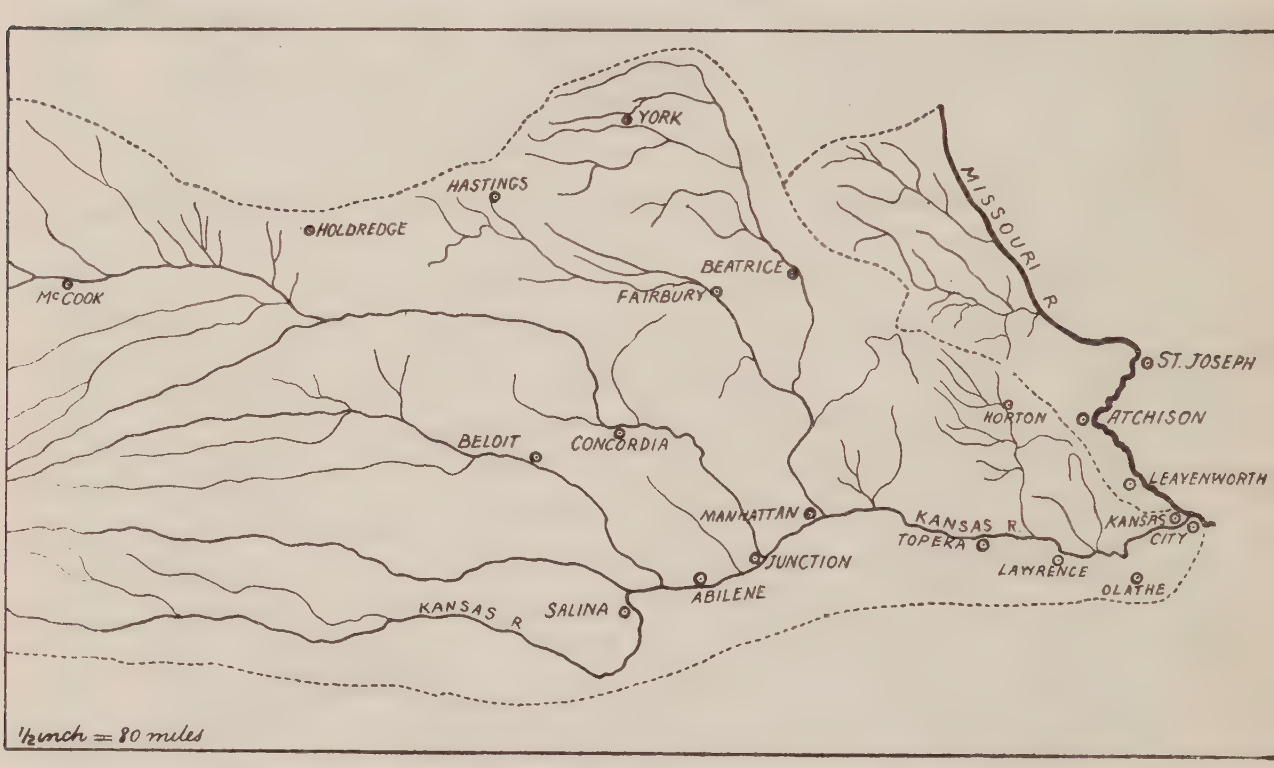
MAP 3.—Platte River drainage area showing sewered towns.

South of the Platte the tributary streams on the west bank of the Missouri River are small and unimportant until the Kansas River is reached. The Kansas or Kaw River drains a large territory, including a part of southern Nebraska and the entire northern half of Kansas. The pollution of the stream is little more than rural pollution in the western half of the watershed.

Map No. 4 shows the relation of the cities and towns to each other on the Kansas River watershed.

The following table gives the urban population and the approximate distances from Kansas City:

City, town, or village.	Population, 1910.	Approximate distance from Missouri River.	City, town, or village.	Population, 1910.	Approximate distance from Missouri River.
		Miles.			*Miles.*
Hastings, Nebr.	9,338	260	Abilene, Kans.	4,118	150
York, Nebr.	6,235	240	Junction, Kans.	5,598	130
Fairburg, Nebr.	5,294	185	Manhattan, Kans.	5,722	110
Beatrice, Nebr.	9,356	185	Horton, Kans.	3,600	90
Beloit, Kans.	3,082	210	Topeka, Kans.	43,684	60
Concordia, Kans.	4,415	190	Lawrence, Kans.	12,374	40
Salina, Kans.	9,688	170	Olathe, Kans.	3,272	25



MAP 4.—Drainage area of the Kansas River showing sewered towns.

Thus the eastern part of the watershed receives a considerable urban pollution, especially the last 110 miles from Manhattan to Kansas City, Kans. The last named city is the worst offender, because of the very great pollution contributed by the packing plants.

Map No. 5 shows the tributary streams on the north and south banks from Kansas City to the mouth of the river at St. Charles.

The following table gives the urban population and the approximate distances from the Missouri River:

City, town, or village.	Population, 1910.	Approximate distance from Missouri River.	City, town, or village.	Population, 1910.	Approximate distance from Missouri River.
North of the river:		*Miles.*	South of the river:		*Miles.*
Liberty	2,980	10	Sedalia	17,822	30
Richmond	3,664	10	Marshall	4,869	30
Columbia	9,662	12	Nevada	7,176	150
Fulton	5,228	15	Warrensburg	4,689	50
Marysville	4,762	75	Fort Scott	10,463	170
Trenton	5,656	60	Ossawattomie	4,046	190
Chillicothe	6,205	40	Ottawa	7,650	210
Moberly	10,923	35			

For these reasons the sewage pollution contributed to the Missouri by Plattsmouth, Nebraska City, Lexington, Boonsville, Jeffer-

MAP 5.—Drainage area of the Missouri River in Missouri and a portion of Kansas, showing sewered towns.

son City, and Washington is not a very serious addition to the inevitable pollution which reaches the river from rural sources. The same is true of many of the small cities situated on tributaries within 50 miles of the river.

The pollution carried by these tributaries from Le Mars, Missouri Valley, Olathe, Liberty, Richmond, Marshall, and Warrensburg is negligible considering the size of the towns, the long stream flow, and the dilution effected in the Missouri River. A large amount of pollution is received into the Platte and Kansas Rivers from Lincoln, Fremont, Topeka, Lawrence, and other cities.

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Population of cities on the Missouri River.

City.	1910	1900	Distance from mouth of river.	City.	1910	1900	Distance from mouth of river.
			Miles.				*Miles.*
Sioux City	47,828	33,111	807.4	Kansas River			392.0
Council Bluffs	29,292	25,802	659.8	Kansas City, Kans.	82,331	51,418	391.8
Omaha	124,096	102,555	659.8	Kansas City, Mo.	248,381	163,752	390.7
South Omaha	26,259	26,001	656.0	Lexington	5,242	4,190	322.0
Nebraska City	5,488	7,380	607.7	Boonsville	4,252	4,377	205.8
Platte River			635.0	Jefferson City	11,850	9,664	151.3
Plattsmouth	4,287	4,964	634.5	Osage River			141.7
St. Joseph	77,403	102,979	479.0	Gasconade River			110.0
Atchison	16,429	15,722	446.8	Washington	3,670	3,015	71.4
Leavenworth	19,363	20,735	421.8	St. Charles	9,437	7,982	28.0

Population in 1900 and 1910—Places within 50 miles of the Missouri River.

City, town, or village.	1910	1900	City, town, or village.	1910	1900
Le Mars, Iowa	4,157	4,146	Liberty, Mo	2,980	2,407
Missouri Valley, Iowa	3,187	4,010	Independence, Mo	9,859	6,974
Glenwood, Iowa	4,052	3,040	Richmond, Mo	3,664	3,478
Fremont, Nebr	8,718	7,241	Columbia, Mo	9,662	5,651
Lincoln, Nebr	43,973	40,169	Fulton, Mo	5,228	4,883
Falls City, Nebr	3,255	3,022	Sedalia, Mo	17,822	15,231
Olathe, Kans	3,272	3,451	Marshall, Mo	4,869	5,086
Lawrence, Kans	12,374	10,862	Warrensburg, Mo	4,689	4,724

The greater part of the urban pollution is probably contributed by the cities situated directly on the Missouri River. The towns situated on the tributaries are, as a rule, so much smaller, and at such distances from the Missouri, that it is quite probable that their sewage has no appreciable effect in increasing the pollution of this river. Indeed, it is more likely that the tributary streams generally, with the exception of the Kansas River, although they carry a certain amount of sewage from small towns, are relatively less polluted than the Missouri, and hence tend to decrease the pollution of the latter by dilution rather than to increase it.

Obviously the most considerable urban sewage pollution takes place between Omaha and Kansas City, Mo., where, within a distance of approximately 265 miles, the river receives the sewage of Omaha, Council Bluffs, Nebraska City, Plattsmouth, St. Joseph, Atchison, Leavenworth, Kansas City, Kans., and Kansas City, Mo., these cities having an aggregate population of over 600,000.

RESULTS OF BACTERIOLOGIC EXAMINATION.

The examinations of water as outlined in the preceding section were made at 19 different sampling points; 973 samples were examined by the various laboratories, as follows:

Kansas State Board of Health	339
Kansas City, Mo., Hospital and Health Board	238
St. Joseph, Mo., City Health Department	159

Omaha City Department of Health	100
Nebraska State Board of Health	62
Missouri State Board of Health	50
Iowa State Board of Health	25
Total	973

The complete detailed results of these examinations are published in the appendix. For convenience in considering these results, monthly averages were struck, and the following table shows averages at each sampling point for the two months June and July, 1912:

Distance from nearest sampling point above.	Sampling point.	June.			July.		
		Average total count.	Number of samples taken.	Average B. coli per cubic centimeter.	Average total count.	Number of samples taken.	Average B. coli per cubic centimeter.
Miles.							
0	1. Sioux City	....	....	....	35,320	25	56
140	2. Omaha, above city	5,432	24	92	6,260	24	250
4	3. Omaha, below city	10,087	24	156	11,534	24	452
30	4. Plattsmouth, Platte River	9,628	7	....	35,588	24	38
	5. Plattsmouth, Missouri River	9,335	7	....	102,860	24	114
150	6. St. Joseph, above city	8,074	23	255	11,322	31	162
	7. St. Joseph, below city	10,430	23	311	21,519	31	369
	8. St. Joseph, below packing plants	63,602	23	18,882	54,570	31	25,587
30	9. Atchison, above city	21,430	13	307	29,613	25	323
	10. Atchison, below city	76,370	13	293	41,235	25	250
25	11. Leavenworth, above city	16,111	17	227	27,636	26	301
	12. Leavenworth, below city	30,958	17	301	21,266	26	312
0	13. Kansas River, Lawrence	11,644	18	284	18,644	27	140
20	14. Kansas River, Bonner Springs	14,500	15	370	24,772	27	363
20	15. Kansas River, Kansas City	120,518	33	2,006	63,222	29	2,214
23	16. Missouri River, above Kansas City	57,100	33	129	24,000	29	239
10	17. Missouri River, below Kansas City	178,258	33	1,562	47,666	29	2,517
12	18. Missouri River, Independence	69,421	21	820	32,290	29	836
230	19. Missouri River, Jefferson City	27,400	25	146	19,428	26	293

In addition to the bacteriological examinations, the Kansas State Board of Health also made chemical examinations of samples from the Missouri River at Atchison and Leavenworth and from the Kansas River at Lawrence, Bonner Springs, and Kansas City, Kans. These examinations were made by Mr. Young at the water and sewage laboratory, Lawrence, Kans., and will doubtless be the subject of a special report by the State Board of Health of Kansas. The data on the Kansas River are of especial interest and value because of the gross pollution of that stream by the packing plants and sewage at Kansas City; for this reason the results of chemical examinations are also included in the appendix to this report.

It was not possible to get samples at all the desirable points; in fact, the writer was compelled to accept such points as the local authorities were able to cover. As a result several intermediate points of considerable value in showing the effect of stream flow on pollution were left uncovered. The points were selected, however, as far as possible, to show the maximum pollution at each place and the effect of the natural agencies of purification operative in a given number of miles of stream flow.

The average bacterial count at Sioux City (sampling point 1) in July was 35,320. The samples were taken below the sewers of the city, and the average B. coli content per cubic centimeter was 56. The average total bacterial count at the next point, Omaha, a distance of about 140 miles below, is only about 6,000. On the other hand, while the total count is greatly reduced, the B. coli count above Omaha (sampling point 2) is higher than at Sioux City. The maximum pollution of the water at Sioux City is probably nullified by a much lesser distance than 140 miles, and the increase in B. coli above Omaha is due to local fecal pollution from near-by sources, probably from the sewage pollution of Mill Creek and other sources mentioned by Lumsden.[1]

The samples taken in the Platte River above Plattsmouth (sampling point 4) show that the Platte probably does not increase the pollution of the Missouri. The B. coli content in the Platte was 38 per cubic centimeter lower than at any sampling point on the Missouri River.

The three sampling points (sampling points 6, 7, and 8) at St Joseph were placed one above the city, one below the principal city sewers, and the third still farther downstream just below the packing plants.

The first sampling point above the city was 180 miles below Omaha and about 150 miles below the mouth of the Platte. The amount of sewage directly contributed between Omaha and St. Joseph is negligible, and the pollution of the water above St. Joseph is largely from rural sources. The B. coli content below Omaha was 452 per cubic centimeter in July and above St. Joseph 162 per cubic centimeter. In June an average B. coli content of 156 per cubic centimeter at Omaha was exceeded at St. Joseph, which had an average of 250 per cubic centimeter. This suggests that the B. coli content in the Missouri River is high independent of the sewage of cities, and that if the city sewage was excluded the bacterial count and B. coli content would still be such as to demand very thorough purification.

The effect of the city sewage on the bacterial counts and B. coli content is very constant in both June and July, the B. coli content rising to over 300 per cubic centimeter in each month (sampling point 7). Even more striking is the effect of the pollution from the packing plants. This factor, besides enormously increasing the total count, greatly increases the B. coli content per cubic centi-

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[1] Lumsden, L. L.: Hygienic Laboratory Bulletin 72.

meter, which was over 18,000 in June and 25,000 in July. This maximum pollution at St. Joseph is reduced in 30 miles of stream flow to about 300 B. coli per cubic centimeter, as shown by the counts above Atchison (sampling point 9). The sewage of Atchison seems to have no effect in increasing the B. coli content.

The samples below Atchison (sampling point 10) show an increase in total count, but a slight decrease in the B. coli content.

The average of about 300 B. coli per cubic centimeter is maintained in the samples both above and below Leavenworth (sampling points 11 and 12). Sampling point No. 16 was at Quindaro, about 23 miles below Leavenworth, and 7 miles above the mouth of the Kansas or Kaw River. The samples taken at Quindaro showed a decrease in the B. coli content in both June and July as compared with the Leavenworth samples.

The samples taken from the Kansas River at Lawrence (sampling point 13) had 140 B. coli per cubic centimeter in July and an average of 284 per cubic centimeter in June. Bonner Springs (sampling point 14) showed a higher B. coli content, there being over 360 per cubic centimeter in both months. The maximum pollution of the Kansas River is near its mouth at Kansas City (sampling point 15). This is due to the sewage of Kansas City, Kans., and a portion of Kansas City, Mo., but especially to the wastes from the packing plants. The samples were taken a considerable distance (about 1 mile) below the worst sources of pollution and showed an average total bacterial count of 120,000 and a B. coli content of 2,006 per cubic centimeter in June. In July the total count averaged 63,000 and the B. coli content 2,214 per cubic centimeter.

The pollution shown at sampling point 17, below the principal sewer outlets of Kansas City, Mo., is due to the combination of polluted water from the Kansas River and the sewage of Kansas City, Mo.

The total bacterial counts and the B. coli content per cubic centimeter are very high below Kansas City's sewers, and, in July, the B. coli content averaged 2,517 per cubic centimeter.

Samples taken at the waterworks station, Independence, Mo. (sampling point 18), about 12 miles below Kansas City, show the effect of 12 miles of stream flow upon the grossly polluted water at Kansas City. The distance is too short to effect great purification, considering the enormous amount of wastes discharged into the stream at Kansas City, but an appreciable purification is effected. The bacterial count is reduced and the B. coli content drops to an average of about 800 per cubic centimeter.

Sampling point No. 19 was located at Jefferson City, Mo., and represents Missouri River water, with the almost unavoidable rural pollution. The urban pollution probably plays little part, since Kansas

City is 240 miles upstream and the nearest source of direct sewage pollution is Booneville, about 54 miles above. In the stream flow of 240 miles the bacterial counts and B. coli content approach the condition of Missouri River water at Leavenworth or Quindaro.

It is likely that this degree of pollution, which seems to be normal under existing conditions (about 300 B. coli per cubic centimeter), is reached in much less than 240 miles, but it was not feasible to secure samples between Independence and Jefferson City.

The B. coli content is a more reliable index of sewage pollution than the total bacterial count. The two indices very often show a striking parallelism but are not always in accord. In the following charts (10, 11, 12, 13, 14, 15, 16, and 17) both bacterial counts and the B. coli content per cubic centimeter are illustrated. If deductions may be made, they would be based on the B. coli content. In June the normal B. coli content per cubic centimeter was about 150 per cubic centimeter, as evidenced by the average counts at Omaha, Quindaro, and Jefferson City, and in July from 250 to 300.

These samples were taken at points many miles below any source of urban pollution. Considering the enormous stream flow available for dilution and the remarkable quality of sedimentation which the Missouri River possesses, the high B. coli content at such points can not be attributed to city sewage.

The following table from the reports of the United States Geological Survey shows the enormous stream flow of the Missouri River:

Monthly discharge of Missouri River at Kansas City, Kans., for period Apr. 1 to Dec. 31, 1905, inclusive.

[Drainage area, 492,000 square miles.]

Months.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
April	84,800	33,600	48,990
May	138,300	44,700	81,170
June	148,800	73,700	111,800
July	236,000	91,550	150,800
August	105,800	45,150	77,740
September	168,000	30,700	71,000
October	49,680	28,250	35,560
November	54,500	30,350	38,520
December	42,450	16,250	25,750
The period	236,000	16,250	....

During June, 1905, the mean stream flow was 111,000 cubic feet per second and in July 150,000 cubic feet per second. During June and July, 1912, it may be presumed that the volume was about the same.

The turbidity of the Missouri River is very great, turbidities of 3,000 to 8,000 parts per 1,000,000 (silica standard) being not uncommon. The enormous quantity of suspended matter undoubtedly serves as a purifying agent as sedimentation takes place.

In view of these circumstances the sewage of small urban communities of less than 5,000 people can not have a marked effect upon the character of the Missouri River water for more than a few miles beyond the sewer outlets. Yet at Jefferson City, 240 miles below Kansas City and 54 miles below Boonville (which has less than 3,000 people tributary to sewers), a B. coli content of from 150 to 300 per cubic centimeter was found. The most logical explanation, and an inference which is unavoidable, is that the high B. coli count in Missouri River water is due largely to the washings from the rather populous watershed. "Populous" is used here to indicate not only human beings per square mile but also cattle and hogs. Independent of city sewage, the tributary streams and the Missouri itself receive in flood times the washings of manured fields, grazing land, and hog farms, as well as the washed-out contents of privy vaults, cesspools, and small sewerage systems.

SIOUX CITY, IOWA.

Sioux City, Iowa, grew from a small city of 7,366 in 1880 to 37,806 in 1890. It suffered a loss in the next decade, registering 33,111 inhabitants in 1900. During the past decade the city has had a substantial growth, and in 1910 had a population of 47,828. The importance of Sioux City as a center in interstate traffic may be expected to increase. There will also be an increase in the amount of pollution which it contributes to the Missouri River.

SEWERAGE SYSTEM.

The sewage of Sioux City is discharged into the Missouri River by four principal outlets at the foot of the following streets: Water Street, Nebraska Street, Virginia Street, and Court Street.

The largest discharge is at Court Street, and this amounts to about 40 per cent of the total sewage discharged directly into the Missouri. The Floyd River receives sewage from three outlets of the city sewerage system and also the sewage and wastes from the stockyards. The Floyd River discharges into the Missouri at the foot of Clark Street, about four blocks below the Court Street sewer. Sioux City is a well-sewered city, but there are more than 1,000 privies in use.

WATER SUPPLY.

The public water supply of Sioux City is from deep wells and its security from pollution is conceded. However, it is one thing to have a safe water supply and quite another to have all the people use it. As in other rapidly growing towns, there are about 1,000 shallow wells which must be regarded as questionable sources of supply.

TYPHOID FEVER IN SIOUX CITY.

Following are the number of deaths from typhoid fever occurring in Sioux City as shown by the death certificates on file at the office of the secretary State board of health:

Month.	1905	1906	1907	1908	1909	1910	1911	Total by months.
January	0	0	1	2	3	0	0	6
February	0	1	1	0	1	1	1	5
March	0	0	0	0	1	0	0	1
April	1	0	0	0	0	1	0	2
May	1	0	1	2	0	1	1	6
June	0	1	1	0	0	1	1	4
July	0	0	0	1	0	1	1	3
August	3	1	1	2	1	2	3	13
September	1	0	1	0	5	0	1	8
October	0	2	1	2	3	3	1	12
November	0	2	0	0	0	4	0	6
December	4	1	1	3	2	1	1	13
Total by years	10	8	8	12	16	15	10	....

The rate was comparatively low in 1901, 1903, 1904, 1905, 1906, and 1907. It was excessive in 1900, 1902, 1908–9, and 1910. In 1911 the death rate fell to 20 per 100,000. Monthly statistics were not available before 1905. The high rates for 1908 and 1909 were due to an excess in December, January, and May, 1908; December, January, February, and March, 1909. In 1910 the excess was not in the winter and spring months; 1911, with a low rate, presents a typhoid curve resembling that of cities with safe water supplies.

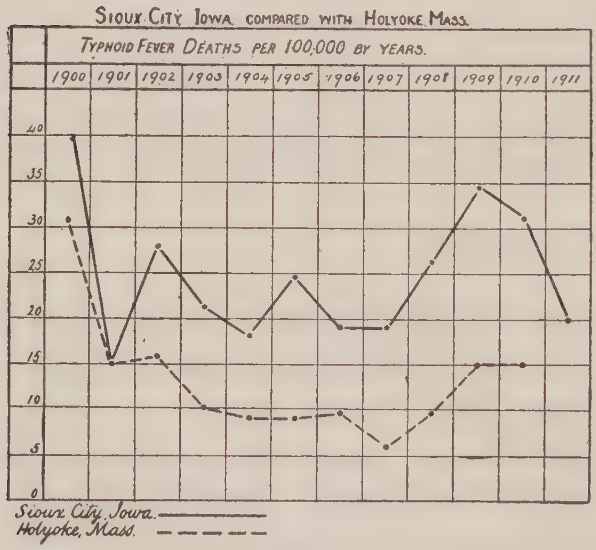

CHART 1.

If water plays any part in typhoid transmission in Sioux City, as suggested by the seasonal prevalence in 1908 and 1909, it is probably water from private wells or other questionable sources. With its excellent public water supply and the elimination of privies and shallow wells, Sioux City should effect a marked reduction in typhoid fever rates.

Chart 1 shows typhoid fever rates in Sioux City since 1900 compared with Holyoke, Mass. The Sioux City rates since 1901 are consistently higher than those of Holyoke. The public water supply of both cities is conceded to be safe. Only an intensive study of local conditions can show definitely what factors are responsible for the higher rate in Sioux City. There is no reason why Sioux City should not discover and correct these defects and bring the typhoid fever death rate down to 10 per 100,000 or less.

COUNCIL BLUFFS, IOWA.

Council Bluffs has had a steady though not rapid growth since 1880. The population in 1910 was 29,292.

SEWERAGE SYSTEM.

The existing sewerage system of Council Bluffs is not extended over the entire city. A large part of the eastern portion of the city is sewered and this system discharges into Indian Creek at Nineteenth Avenue. Indian Creek discharges into the Missouri River about 2 miles below the Union Pacific Railroad bridge. The western half of the city is largely unsewered. The country is flat and there is probably not sufficient grade to carry sewage to the Missouri, and pumping may be necessary. The city officials are now working on this problem. There are thousands of privies in use at present, and these can not be eliminated until the sewerage problem is solved.

WATERWORKS

The public water supply is derived from the Missouri River. The water is subjected to short storage and treated with alum. In May, 1910, the use of hypochlorite was begun and is still being used. The public water supply does not reach all the people, and it is estimated that there are over 2,000 shallow wells in Council Bluffs.

TYPHOID FEVER.

Statistics of typhoid fever deaths in Council Bluffs are available since 1905. The typhoid fever death rate was excessive in 1909 and 1910, and in 1907 was above 20 per 100,000. In the other years the rate was low.

The high rates from 1907 to 1909 and 1910 were due to an increase of deaths in the winter and spring months.

Deaths per 100,000, typhoid fever.

Year.	Deaths.	Year.	Deaths.
1905	18	1909	28
1906	4	1910	46
1907	21	1911	13
1908	14		

Deaths, typhoid fever, by months, 1905 to 1911.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly total.
1905				1					2		2		5
1906									1				1
1907	1	2	1									2	6
1908									2		1	1	4
1909				1	1		1	1			1	3	8
1910	2	3	3	3		1						2	14
1911	1							1				2	4
Total	4	5	4	5	1	1	1	2	5	0	4	10	

Chart No. 2 shows the difference between the typhoid curve for the years with low rates compared with the curve for the years with high rates. The former (solid line) has a very low rate for the winter and spring months, and the latter (dotted line) has a low rate in summer and autumn and very high rates in December, January, February, March, and April.

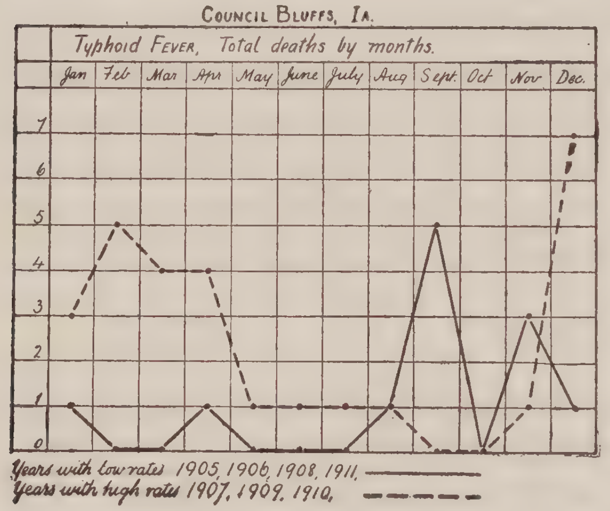

CHART 2.

The curve for the years with high typhoid rates is very suggestive of water-borne infection. After the outbreak in the winter of 1910, hypochlorite treatment of the water supply was begun. Since that time (Apr., 1910, to Dec., 1911) the typhoid rate has been very low, in 1911 being only 13 per 100,000. Water-borne typhoid in cities of this type is not entirely due to the public supply. It may be largely due to contaminated wells. There are over 2,000 of these shallow wells in Council Bluffs, and these, together with the thousands of privies, must be considered a great menace to the public health.

The treatment of the water supply with hypochlorite was a step in the right direction, and its continuance, and the gradual elimination of the shallow wells and privies will do much to insure low rates for typhoid fever in the future.

OMAHA, NEBR.

The city of Omaha had a population in 1910 of 124,000. A comprehensive survey of sanitary conditions in Omaha was made in 1910 by Surg. L. L. Lumsden, United States Public Health Service,[1] following the typhoid-fever outbreak of 1909–10. In order to avoid duplication, I shall omit much of the sanitary data which were presented by Dr. Lumsden in Bulletin 72.

[1] Lumsden, L. L.: Hygienic Laboratory Bulletin No. 72.

SEWERAGE SYSTEM.

About 80 per cent of Omaha's population is provided with sewers and the remainder still use privies. The sewers discharge into the Missouri River by seven outlets. In addition, there is one outlet into a creek. The sewage discharged into the creek is treated first in a septic tank.

WATER SUPPLY.

The water supply of Omaha is derived from the Missouri River. Since the outbreak of 1909–10 the supply has been carefully treated. The water is very turbid, and a series of basins allows for sedimentation of much of the suspended matter. In the second basin the coagulant (alum) is applied. Since 1910 hypochlorite has been used as an adjuvant with excellent results. There is total storage capacity for less than one day's supply, but the result of sedimentation with the use of alum and treatment with hypochlorite without filtration seems to be effective, judged by bacteriologic results.

TYPHOID FEVER.

Typhoid-fever death rates in Omaha have fluctuated from 11.5 in 1903 to 86.7 per 100,000 in 1910. As a rule, they have been below 30 and frequently below 20 deaths per 100,000. In 1910 there was a very ususual prevalence in winter months.

Deaths from typhoid fever reported by months in Omaha.[1]

Month.	1905	1906	1907	1908	1909	1910	1911	1912	Total by months.
January	1	2	3	1	1	4	6	1	19
February	2	3	....	2	1	20	1	1	30
March	4	2	1	2	1	27	2	1	40
April	1	0	4	....	4	9	2	0	20
May	....	2	1	....	....	6	1	....	10
June	3	3	1	1	3	3	1	....	15
July	1	1	1	1	2	3	2	....	11
August	1	....	1	2	3	10	1	....	18
September	3	2	2	5	6	13	3	....	34
October	2	5	4	1	3	9	1	....	25
November	2	4	3	2	2	4	1	....	18
December	1	4	4	9	11	2	1	....	32
Total, by years	21	28	25	26	37	110	21	....	....

[1] These figures were obtained from local records. The total for the year in some instances does not coincide with the rates given by the United States census. No monthly records were available from the United States census reports, so that in spite of apparent discrepancy it was necessary to use these local records of deaths by months in order to estimate seasonal prevalence.

The typhoid-fever history of Omaha was fully discussed in Hygienic Laboratory Bulletin 72 by Surg. Lumsden. Speaking of the outbreak of 1909–10, he says:

Water.—The unusually high rate of prevalence or outbreak of typhoid fever in Omaha during the period extending from about November 25, 1909, to about March 25, 1910, was beyond reasonable doubt caused by infection in the water supply obtained from the Missouri River. Some of the points in the evidence on which this conclusion is based are as follows:

(*a*) The river water obtained at both intakes was polluted to a dangerous extent with sewage.

(*b*) The results of the bacteriologic examinations show that during the period in which the outbreak was caused the treatment of the water, previous to its distribution to the city, by storage and by the use of a coagulant was not efficient to render this water reasonably free from dangerous pollution.

(*c*) The vast majority, over 95 per cent of 103 cases particularly investigated, were in persons who during the 30 days prior to onset of illness used as the sole, principal, or occasional source of water for drinking purposes the unboiled and unfiltered tap water as supplied from the river through the city water system, and besides this water there was no factor common to the majority of the cases which could reasonably be considered as having been concerned in the production of the disease.

(*d*) There was a parallelism between the occurrence of certain unusual climatic conditions which particularly affected the river water and the unusual prevalence of typhoid fever, which very strongly suggests a relationship of cause and effect.

(*e*) Reports from a number of other cities for the period in which the outbreak at Omaha occurred showed that in those cities which were using water from the Missouri River the typhoid-fever rates generally were unusually high, while in cities neighboring these but using water from other sources such as wells, springs, lakes, etc., the typhoid-fever rates generally were not unusually high.

(*f*) Among persons who habitually used for drinking the water distributed from the Burnt Street station—which water in the winter of 1909–10 was exposed to greater sewage pollution than it had been in any other winter for certainly many previous years and to relatively more sewage pollution from near-by sources than was the water distributed from the Florence intake—the disease appeared to prevail at a rate which was disproportionately high.

(*g*) The time of occurrence and the extent of the outbreak point to the water supply as the source of the infection.

(*h*) The results of the investigation eliminate, beyond reasonable doubt, all possible sources of infection other than the water supply which could have been responsible for an outbreak of such character.

Since the outbreak in 1910 and the installation of the hypochlorite treatment there has been marked improvement in the typhoid fever rate. There were 6 deaths in January, 1911, but during the rest of the year only 16 deaths occurred, and the yearly death rate from February 1, 1911, to February 1, 1912, was only 13.7 per 100,000. High rates persisted throughout 1910, and the high rate in January, 1911, may be, perhaps, considered as a result of the 1910 outbreak. Yet, including January, the entire year 1911 had the lowest rate since 1903. (See chart No. 3.)

SOUTH OMAHA, NEBR.

South Omaha had a population of 26,246 in 1910. It is a city which owes its existence to the meat-packing industry. About 80 per cent of the population has access to sewers of the combined type. These discharge by four outlets into the Missouri River. South Omaha not only contributes its house sewage to the Missouri, but the enormous quantities of organic wastes from the stock yards and packing plants are also contributed.

ST. JOSEPH, MO.

St. Joseph is a flourishing city with great meat-packing industries. Its population has shown some remarkable fluctuations. In 1890 it was credited with 52,324. In 1900 it was alleged that the population had reached 102,979. The 1910 census showed 77,403. It is not improbable that the 1900 census exceeded the actual resident population, and that the decrease in the past decade was more apparent than real.

SEWERAGE SYSTEM.

The sewerage system is of the combined type. There are about 100 miles of sewers emptying by 14 outlets into the Missouri River. These vary in size from 15 inches to 17½ feet in diameter. About three-fourths of the population have access to the sewers, the remainder depending upon privies. Below the last sewer outlets, the wastes from the packing plants are discharged into the river.

CHART 3.

WATERWORKS.

The public water supply of St. Joseph is taken from the Missouri River, by two intakes, 24 and 36 inches in diameter, respectively. It is pumped to a 3,000,000-gallon basin divided into two compartments. The first compartment acts as a mud basin, and much of the turbidity is lost before the second compartment is reached. Alum is applied in the second compartment. A 36-inch conduit conducts the water to another 3,000,000-gallon basin, which is sufficiently high to deliver the water to the filters by gravity.

There are 14 filter units each of 700,000 gallons capacity in 24 hours. The filter units are of the rapid sand type. From the filters the effluent is carried to a clearwater basin of 1,250,000 gallons capacity.

From the clearwater basin the water is pumped to reservoirs having 16,000,000 gallons capacity, 327 feet above the river and delivered to the city by gravity. Hypochlorite of lime is applied before the water is pumped to the high reservoirs. In addition to this system there is a reserve reservoir in the city of 3,000,000 gallons. The daily consumption is about 7,500,000 gallons. Many shallow wells still exist in St. Joseph, especially in the lower portions of the city near the river. It is estimated that there are 2,000 of these shallow wells.

TYPHOID FEVER.

From 1901 to 1908, according to recorded statistics, St. Joseph had consistently the lowest rate for typhoid fever of any city in the United States.[1] During this period the annual average death rate per 100,000 for typhoid fever was only 12.5. In 1909 the rate was higher and in 1910 reached 38.8 per 100,000. Typhoid fever was unusually prevalent along the Missouri River in the winter of 1909 and 1910, and the rate in St. Joseph was unusually high in January, February, and March, 1910.

The water purification plant is capable of furnishing safe water at all times. It must be remembered that there are a considerable number of shallow wells in St. Joseph. In times of heavy rain, thaws, and floods these become contaminated, and the board of health traced many cases to these wells in 1911.

ATCHISON, KANS.

Atchison had a population in 1910 of 16,429.

SEWERAGE SYSTEM.

The sewage of Atchison is discharged into the Missouri, the bulk of it by means of White Clay Creek. The sewage from St. Benedict's College and other sources was formerly discharged above the waterworks intake. Sewage from above the waterworks is now intercepted and discharged below the waterworks at Utah Avenue.

WATERWORKS.

The public water supply is taken from the Missouri River and pumped to a series of four reservoirs, two of 2,000,000 gallons, one of 1,500,000 gallons, and one of 5,000,000 gallons capacity. The daily consumption is 1,250,000 gallons, so that there is storage for several days' supply. Alum is applied after the first sedimentation.

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[1] Crediting St. Joseph with very low rates for typhoid fever, one must take into account some remarkable discrepancies in population statistics. There is a question of the accuracy of statistics showing such remarkable fluctuations.

The first basin of 2,000,000 gallons acts as a mud basin. As the water passes the second basin of the same size the alum is applied. Further sedimentation and storage is afforded by the 1,500,000-gallon and the 5,000,000-gallon basins. No hypochlorite is used, although there is an excellent opportunity to use it with good results.

TYPHOID FEVER.

Typhoid fever rates have been excessive in Atchison and there is little doubt that the public water supply has played a part in this excessive prevalence. In 1909 the death rate was 68 per 100,000. In the months from January to June the rates are very suggestive of water-borne infection. Year after year there have been many deaths from typhoid fever in the winter and spring. In six years, 1906 to 1911, there were 22 deaths in the months from January to June, and only 19 from July to December.

Typhoid deaths by months.

	1906	1907	1908	1909	1910	1911
January	....	....	....	1	2	0
February	....	....	....	1	....	1
March	1	2	....	1	....	2
April	2	....	1	....	....	2
May	....	....	1	....	2	1
June	....	1	....	....	1	....
July	2	1	....	....	....	1
August	....	....	1	....	....	....
September	1	....	....	2	1	....
October	....	....	....	1	....	....
November	....	1	....	4	1	1
December	....	....	....	1	1	....
Total	6	5	3	11	8	8
Death rate per 100,000	42	35	20	68	50	50

Typhoid fever, annual death rate per 100,000, by one-half year periods.

Year.	January to June.	July to December.	Year.	January to June.	July to December.
1906	42	42	1909	42	100
1907	42	28	1910	62	38
1908	13	6.5	1911	75	25

Such persistently high rates in the winter and spring indicate that the public water supply is a factor of importance in this excessive prevalence.

The table following shows the quality of the public water supply to be dangerous and the purification ineffective.

Public water supply, Atchison, Kans., 1912.[1]

Date.	Total bacteria.	B. coli present in—	Date.	Total bacteria.	B. coli present in—
		c. c.			c. c.
June 13	90	10	July 9	300	.1
June 14	10,000	10	July 10	300	.1
June 15	400	10	July 11	600	.1
June 18	200	.01	July 12	....	.1
June 19	290	.01	July 13	....	....
June 20	145	1	July 15	1,100	.1
June 22	60	Absent.	July 16	1,700	.1
June 24	170	.1	July 17	700	10
June 25	120	1	July 18	1,100	1
June 26	120	10	July 19	....	....
June 27	20	1	July 20	180	1
June 28	165	1	July 22	1,400	.1
June 29	140	10	July 23	620	1
July 1	11,600	10	July 24	520	.1
July 2	287	1	July 25	1,800	1
July 3	390	.01	July 26	770	.1
July 5	2,800	10	July 27	800	1
July 6	380	1	July 30	170	1
July 8	530	.01	July 31	....	.1

[1] Examinations made in the laboratory of the State Board of Health, Lawrence, Kans.

LEAVENWORTH, KANS.

The population of Leavenworth in 1910 was 19,363. There has been a slight decrease in the past decade and the population has been almost stationary since 1890.

SEWERAGE SYSTEM.

The sewers of Leavenworth discharge into the Missouri River by four outlets, as follows:

	Inch.
Poplar Street	12
Chestnut Street	12
Choctaw Street	24
Dakota Street	48

The Dakota Street sewer is the largest and also receives the sewage from Fort Leavenworth.

WATERWORKS.

The public water supply of Leavenworth is taken from the Missouri River. It is pumped to a series of four reservoirs. The first serves as a mud basin, and alum is applied in the second. From the third reservoir the water is pumped to a fourth reservoir of 6,000,000 gallons capacity, 365 feet elevation, from which the water is distributed by gravity to the city. The capacity of the four reservoirs combined is 13,500,000 gallons, sufficient for about two and a half days' supply, the daily consumption being about 5,000,000 gallons. Hypochlorite of lime has been used since May, 1910, in reservoir No. 2.

Deaths from typhoid fever.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1901		1	2	1			3	1	2	3		3	16
1902		2	1	1	2	1	2	7	1	2			19
1903	2	2	1	1	2		3	1		1			13
1904		1	4	5	1	1	1						13
1905	1	2		1					1		1	1	7
1906		1	1			1	1	1			1		6
1907	1		1	1		1			1	1		1	7
1908		1	2	1					2			1	7
1909	2	3	1	1		1		2				1	11
1910	6	1	1			1	1		2	2	1	2	17
1911	3	1	1		1								6
1912													
Total	12	14	14	12	6	6	11	12	9	9	3	9	

TYPHOID FEVER.

Typhoid-fever rates in Leavenworth were excessive in 1900–1901, 1903, and 1904, and have been high ever since. In 1910 the very high rate of 85 was reached. Of the 17 deaths in 1910, 6 occurred in, January. During the 10 years 1901–1910 there were 117 deaths from typhoid fever. Only 21 of these occurred in September, October, and November, and 52 occurred in January, February, March, and April. The consistent predominance of typhoid fever in the winter months indicates water-borne infection.

The following table shows the results of our examinations of samples of the public water supply of Leavenworth in June and July, 1912. The examinations were made in the laboratory of the State board of health, Lawrence, Kans.

Date.	Total bacteria.	B. coli present in—	Date.	Total bacteria.	B. coli present in—
		c. c.			*c. c.*
June 13	50	Absent.	July 19	60	1
14	340	Absent.	20	20	Absent.
17	15	10	21	6	10
18	50	Absent.	22	20	Absent.
19	80	Absent.	24	50	Absent.
20	15	Absent.	25	20	Absent.
21	12	Absent.	26	25	Absent.
22	40	Absent.	27	140	Absent.
24	35	Absent.	28	8	Absent.
25	7	Absent.	29	300	Absent.
26	10	Absent.		21	10
27	10	Absent.		10	10
28	8	Absent.		60	10
29	110	10		12	10
July 13	28	Absent.		200	10
14	10	Absent.		500	1
17	37	Absent.		30	Absent.
18	40	Absent.			

The table shows the superiority of this plant over one in which hypochlorite is not used. (See Atchison.) Safe water from the Missouri River is only possible after treatment, and the treatment must be uniform and efficient to give good results. The table indicates some lack of uniformity in results, and the daily finding of B. coli from July 20 to 25 suggests that the efficiency of the plant left something to be desired during that period.

KANSAS CITY, KANS.

Kansas City, Kans., has had a rather rapid growth. Its population by decades was: 1890, 38,316; 1900, 51,418; 1910, 82,331. This increase in population is largely due to the growth of the meat-packing and allied industries. There are also located there railroad shops of the Santa Fe and the Union Pacific, steel works, and chemical manufactories. The amount of pollution contributed by such a city is out of all proportion to the population.

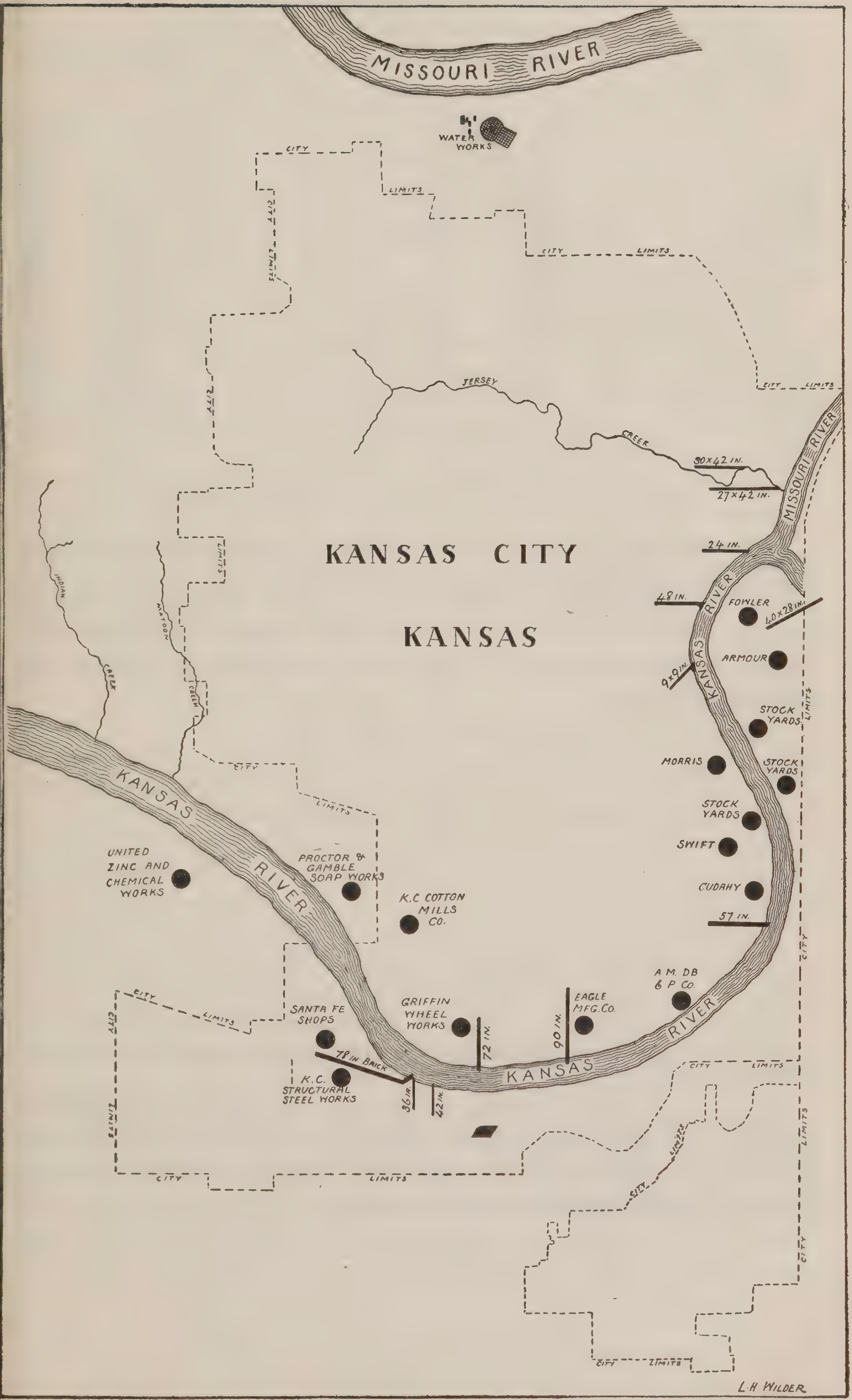
SEWERAGE SYSTEM.

The sewerage system in general is of the combined type and its sewers discharge by 11 outlets into the Kansas or Kaw River, and 1 outlet (draining the section on the east bank of the Kansas) into the Missouri River, crossing the State line and discharging through the system of Kansas City, Mo. Map No. 6 shows the sewer system and also the location of packing plants, stockyards, and factories which contribute enormous quantities of pollution.

WATER SUPPLY.

The source of the supply is the Missouri River near Quindaro (see map No. 6). This site is above the mouth of the Kansas and thus avoids the sewage and wastes from both Kansas City, Kans., and Kansas City, Mo.

There is sedimentation of about two hours in the first reservoir, then alum is applied. Another sedimentation of two hours is secured in the second basin and alum applied a second time. There is a third sedimentation of two hours during flow through the third basin from which the water passes to rapid sand filters. This system works fairly well most of the time. In months of high turbidity (3,000 to 8,000 parts per million silica standard) the sedimentation is insufficient, the water reaches the filters turbid, and the effluent is turbid. The bacterial content of the water has been at such times excessive. During 1912 hypochlorite was used, but the manner of adding the chemical to the water was crude, although possibly effective. The following table shows the results of examinations of water in Kansas City, Kans., from September, 1911, to May, 1912. The analyses were made by the city chemist, Prof. E. A. White.



MAP 6.—Kansas City, Kans. showing sewer outlets, packing plants, stockyards, and factories.

Bacterial count.

Date.	Bacteria per cubic centimeter.		Date.	Bacteria per cubic centimeter.	
	Raw water.	Treated water.		Raw water.	Treated water.
1911.			1912.		
Sept. 27	2,500	100	Jan. 17	3,200	[1] 50
Oct. 4	6,200	100	24	3,000	[1] 30
11	6,000	200	31	3,000	[2] 200
18	6,000	200	Feb. 8	3,000	[1] 25
25	7,000	200	14	3,000	[1] 25
Nov. 1	5,500	190	21	10,000	[1] 40
8	5,000	250	28	10,000	[2] 170
15	5,000	150	Mar. 6	5,000	[1] 70
22	5,000	200	13	30,000	[1] 120
29	4,000	300	20	25,000	[1] 350
Dec. 5	4,000	280	27	30,000	[1] 300
13	4,500	250	Apr. 3	30,000	[1] 300
20	4,000	200	10	30,000	[1] 240
27	4,800	200	17	24,000	[1] 100
1912.			24	9,000	[1] 130
Jan. 3	2,000	100	May 1	13,000	[1] 50
10	3,000	150			

[1] Used bleaching powder. [2] Did not use bleaching powder.

The reduction in total bacteria following the use of hypochlorite is striking, considering the great increase in bacterial content of the raw water during February, March, and April. However, B. coli is present at times in the effluent. Samples taken in July and forwarded to the State board of health laboratory at Lawrence gave the following results:

Tap water, Kansas City, Kans.[1]

Date.	Total bacteria.	B. coli present in—			
		10 c. c.	1 c. c.	0.1 c. c.	0.01 c.c.
July 16	3,000	+	+	+	−
18	740	+	−	....	....
23	1,400	+	+	−	....
24	560	+	+	−	....
26	2,940	+	+	+	−
27	1,670	+	+	+	−
29	95	+	+	−	....
30	270	+	−	+	−
31	130	+	+	+	−

[1] The above samples, although examined some hours after collection, were carefully shipped, and the results may be considered fairly accurate.

These results indicate that the present system of purification is inadequate. When we consider what is accomplished with the same water by the plant at Kansas City, Mo., we must admit that better results are possible and should be secured.

Deaths from typhoid fever, Kansas City, Kans.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.	Rate per 100,000.
1902	2	6	3	1	3	1	4	5	11	5	......	3	44	77.0
1903	5	2	2	6	3	2	5	8	2	10	2	2	49	81.0
1904	5	9	6	5	1	1	2	1	3	8	5	2	48	76.0
1905	4	3	9	5	2	3	5	8	3	4	5	0	51	77.6
1906	5	5	5	3	1	4	1	5	4	7	3	0	43	62.3
1907	1	3	3	5	2	4	9	7	12	4	8	3	61	84.7
1908	1	4	3	0	0	1	2	5	4	1	2	3	26	34.6
1909	2	1	6	6	0	0	1	10	7	3	2	7	45	56.4
1910	4	3	4	4	6	2	3	4	7	8	5	3	53	65.4
1911	3	2	1	1	0	2	9	6	7	0	7	1	39	46.4
1912	0	0	0	1	......	......	......	......	......	......	......	......	......	......

TYPHOID FEVER.

There has been a persistently high prevalence of typhoid fever in Kansas City for years. The average annual death rate per 100,000 for 10 years (1902–1911) is 66.1. In 1907 the rate was 84.7 and in 1910 it was 65.4. This excessive prevalence is produced chiefly by very high rates in the winter and spring months. Chart No. 4 shows the seasonal prevalence of typhoid fever, giving the total deaths by months for a period of 10 years.

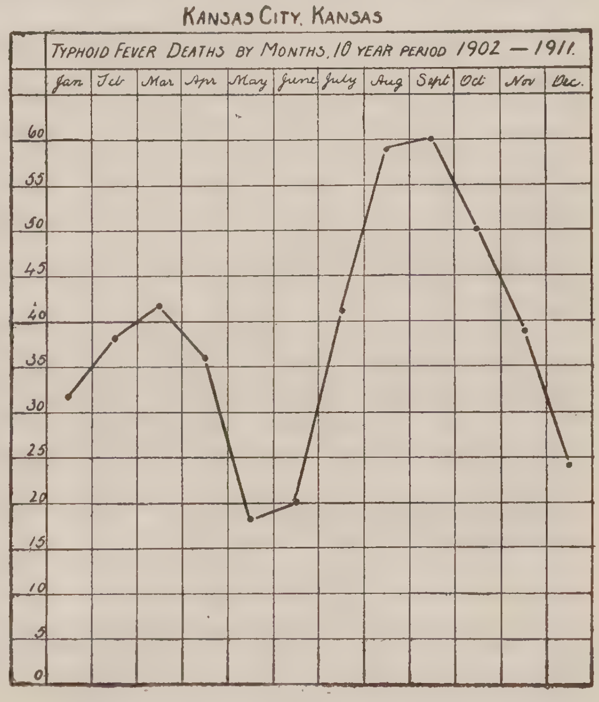


CHART 4.

Chart No. 5 shows the typhoid rate by years since 1902 compared with Yonkers, N. Y., a city of the same size. Yonkers is a mill town and sanitary conditions are not particularly good and there is a very high infant mortality. However, Yonkers has had a good water supply. This can not be said of Kansas City.

The old plant consisted of 10 units of the wooden-tub type, each with a nominal daily capacity of 500,000 gallons. The lack of adequate settling basins caused the partially coagulated mud and water to be rushed to the filters. The raw filters have a daily capacity of 20,000,000 gallons and there is great improvement in the sedimentation, although at times the present 6-hour flow is inadequate and a fourth basin, with an additional 2 hours' sedimentation, would be of great advantage. The addition of hypochlorite seems to have improved the supply and the results are shown in chart No. 6. The death rate from typhoid fever for January, February, March, and

April was never below 35 per 100,000 until 1911, when it dropped to 30. In 1912 hypochlorite was used and the rate dropped to 4.3, this being the first year since 1902 to escape without a single death in January, February, and March.

KANSAS CITY, MO.

Kansas City, Mo., has had a remarkable growth; in 1900 the population was 163,752, and in 1910 it was 248,381. It is a great railroad center, a metropolis for a very large part of three States, and its stockyards and meat-packing industries make it one of the most important commercial centers in the West. Naturally its sanitary condition is a matter of interstate importance.

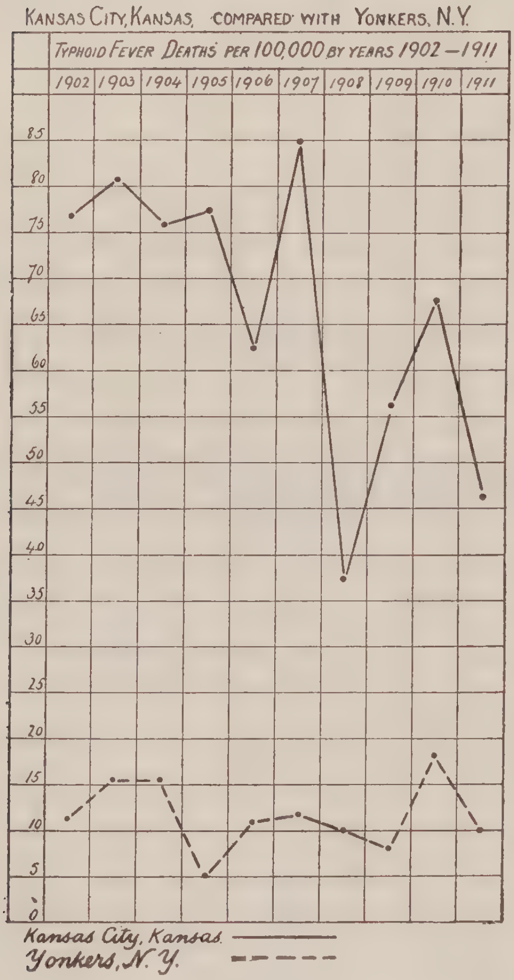


CHART 5.

SEWAGE SYSTEM.

The system is partly separate and partly combined. The outlets into the Blue River are chiefly sanitary sewers; the outlets into the Missouri River and Turkey Creek are of the combined type.

The principal outlets discharge into the Missouri River. There are six of these varying from 4 to 10 feet in diameter. A large district drains into Turkey Creek by means of the O. K. Creek sewer and three other outlets of the combined type. There are four outlets of sanitary sewers into the Blue River and Brush Creek. Map No. 7 shows the location of the sewer outlets.

WATER SUPPLY.

The intake of the Kansas City (Mo.) supply is in the Missouri River at Quindaro, about 5 miles above the city. The raw water is pumped to a reservoir of 90,000,000-gallons capacity. Alum and lime are added after preliminary sedimentation of mud. There is provision for more than two days' sedimentation in the reservoirs at the maximum consumption, as this is less than 40,000,000 gallons daily (July). From the clear well the water returns by gravity to to the pumping station. In its course it receives the hypochlorite.

From the pumping station at Quindaro the clear treated water is pumped to the Turkey Creek reservoir. This basin also has 90,000,000 gallons capacity. From Turkey Creek reservoir there is a high-pressure service maintained by the Turkey Creek station pumping direct into the mains.

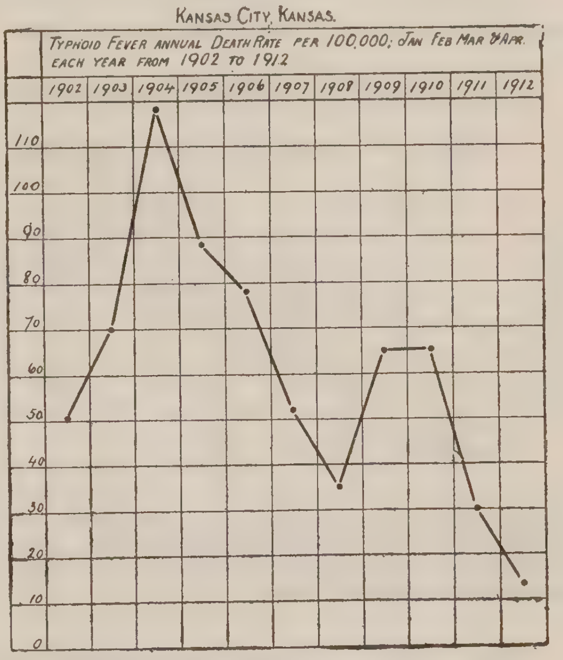


CHART 6.

The use of hypochlorite has been particularly successful, both from the bacteriological and physical stand points. The bacteriologic results are given in the following table. The results are furnished by Mr. Walter Cross, city chemist.

Bacteriological counts of Kansas City, Mo., water.

Date, 1911.	River direct.	Settling basin.	City Hall tap.	Fermentation test for B. coli, City Hall tap.	Date, 1911.	River direct.	Settling basin.	City Hall tap.	Fermentation test for B. coli, City Hall tap.
Mar. 21	8,000	1,800	70	Negative.	Sept. 19	10,000	....	120	Negative.
22	6,000	2,000	(1)	Do.	20	12,000	....	50	Do.
23	4,000	800	100	Do.	21	15,000	1,200	40	Do.
24	10,000	500	55	Do.	22	15,000	....	60	Do.
25	8,000	600	90	Do.	23	20,000	1,500	70	Do.
26	10,000	500	(2)	Do.	24	....	....	....	Do.
27	8,000	400	25	Do.	25	25,000	2,000	80	Do.
28	5,000	260	20	Do.	26	15,000	1,600	70	Do.
29	14,000	300	110	Do.	27	30,000	....	80	Do.
30	20,000	260	210	Do.	28	12,000	1,000	80	Do.
31	30,000	250	190	Do.	29	10,000	1,200	70	Do.
June 19	12,000	600	....	Do.	Dec. 20	10,000	....	60	Do.
20	8,000	500	140	Do.	21	....	....	....	Do.
21	9,000	600	90	Do.	22	8,000	600	50	Do.
22	10,000	1,200	30	Do.	23	....	....	....	Do.
23	9,000	1,100	40	Do.	24	7,000	....	60	Do.
24	12,000	....	90	Do.	25	....	....	....	Do.
25	11,000	850	....	Do.	26	6,000	800	60	Do.
26	....	....	[3] 15	Do.	27	8,000	....	50	Do.
27	3,000	250	160	Do.	28	....	....	....	Do.
28	4,000	300	80	Do.	29	7,000	700	70	Do.
29	....	....	110	Do.	30	6,000	....	60	Do.

[1] Spoiled. [2] Not taken. [3] All molds.

The long flow through the pipe line to the Turkey Creek reservoir after the addition of the hypochlorite and the aeration in the 90,000,000-gallon basin effectually disposes of taste and odor.

TYPHOID FEVER.

The deaths from typhoid fever in Kansas City by months since 1906 are given in the following table:[1]

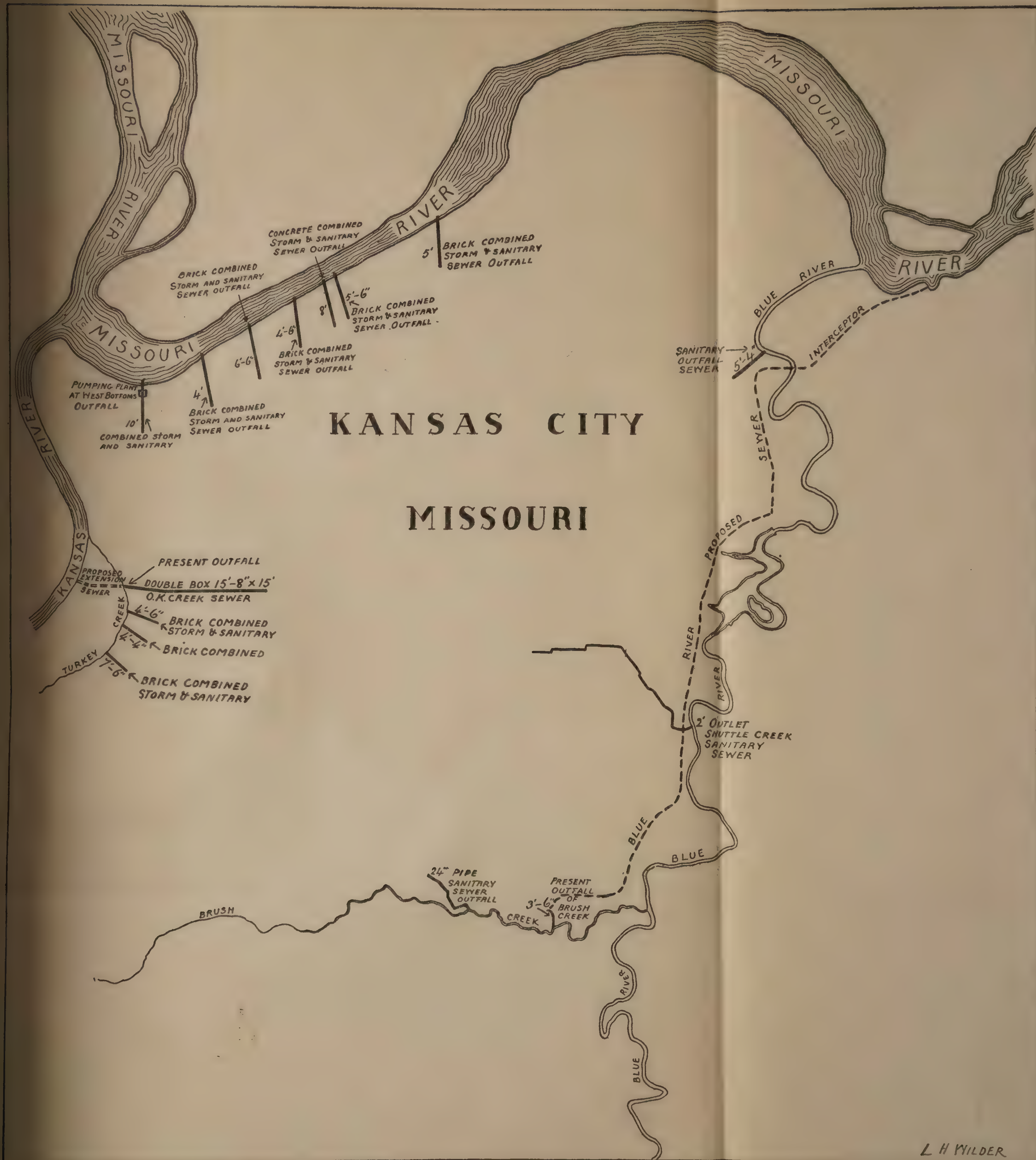
Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total by years.
1906	2	1	2	3	......	......	6	6	5	5	1	3	34
1907	4	3	1	4	3	4	7	6	7	3	5	4	51
1908	2	4	2	4	......	......	2	1	1	1	2	1	20
1909	1	2	2	1	1	2	3	6	4	2	3	3	30
1910	17	21	10	8	3	7	9	8	6	6	4	8	118
1911	6	6	4	5	4	1	5	6	3	8	6	9	63
1912	1	1	5	......	......	......	......	......	......	......	......	......	....
Total by months	33	38	26	25	11	14	32	33	26	25	21	28	....

[1] These figures are taken from local records. The totals for several years do not agree with the figures published in United States Census reports. Unfortunately the United States Census Bureau could not furnish deaths by months, and these local records were the only available sources for estimating seasonal prevalence of typhoid fever.

Chart No. 7 shows the annual typhoid-fever rate by months in 1910 comparing Kansas City with Newark, N. J. Newark has a safe water supply and a curve which is normal for cities which have practically eliminated water-borne typhoid. The height of the epidemic curve in February is striking, and the abnormal rise in June and July noticeable. The further rise in December is characteristic of water-borne typhoid. The year 1910 was an epidemic year, and it is interesting to exclude 1910 and analyze the five lowest years in the last decade—1906, 1907, 1908, 1909, and 1911.

Chart No. 8 shows the seasonal prevalence during these five years compared with the usual seasonal prevalence one finds in cities with safe water supplied. Cincinnati, Ohio, in 1910 is used as a type of this class. Even in these "low" years the contrast is striking. The very much higher rates in January, February, March, and April, the early rise in June and July, and the higher rates in December are at once apparent.

The prevalence of typhoid fever in Kansas City, Mo., has been consistently excessive for many years. Chart No. 9 shows, by years, the rates of Kansas City compared with Jersey City, N. J. Up to 1907 Jersey City depended upon an upland supply derived by impounding streams. This supply was exposed to some pollution, though the raw water was vastly superior to Missouri River water. Since 1907 hypochlorite of lime has been used in treating the supply, and the result is well shown on the chart. In 1908–9 and 1910 the rate in Jersey City averaged 10 deaths per 100,000, while in the same period Kansas City averaged 40. Since 1900 the rate in Kansas City has never been below 30 until 1911.



MAP 7.—Kansas City, Mo., showing sewer outlets.

91318°—13. (To face page 40.)

Water undoubtedly is a big factor in Kansas City's typhoid. It must be borne in mind that water not only includes the public supply, but also hundreds of wells and springs. This is a limestone area, and wells and springs in such territory may furnish an attractive water in physical appearance which may be dangerously contaminated. The city chemist, Mr. Walter Cross, has shown repeatedly that many of these wells are polluted. The bulk of the people have access to the public supply, and the improved treatment of the water since the 1910 epidemic is beginning to show results.

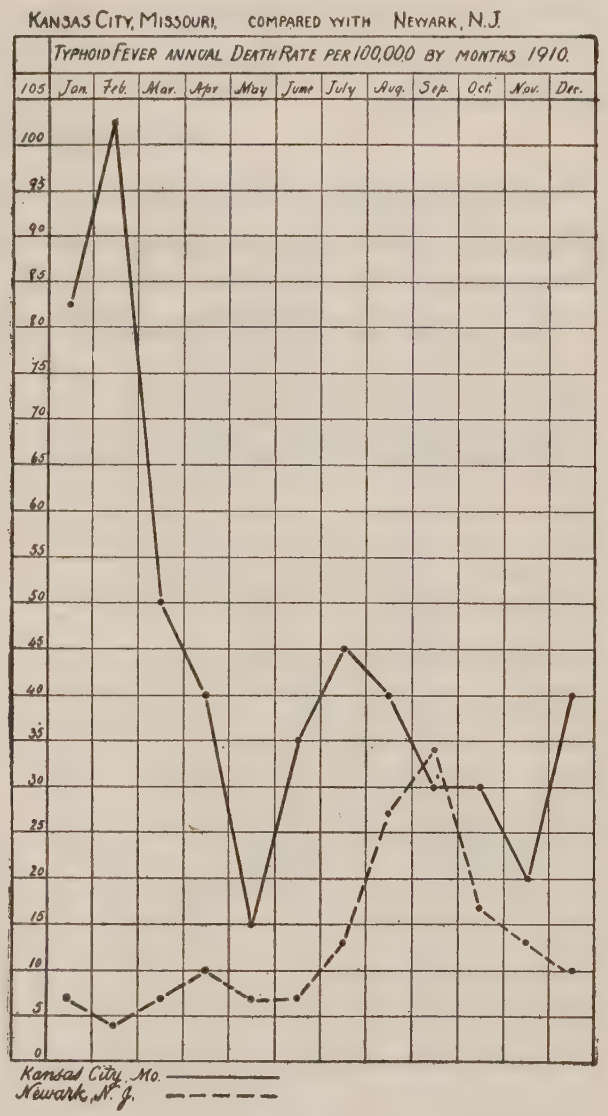


CHART 7.

LEXINGTON, MO.

Lexington is situated on the Missouri River 68 miles below Kansas City. The population in 1910 was 5,242. The sewerage system consists of about 3½ miles of sanitary sewers, discharging by one outlet into the Missouri River. There is no treatment of sewage. About 50 per cent of the population still depend upon privies.

Nearly all the inhabitants use the public water supply, and wells are few. The public water supply is taken from the Missouri River. There is no treatment, but there is a reservoir capacity for between three and four days' supply.

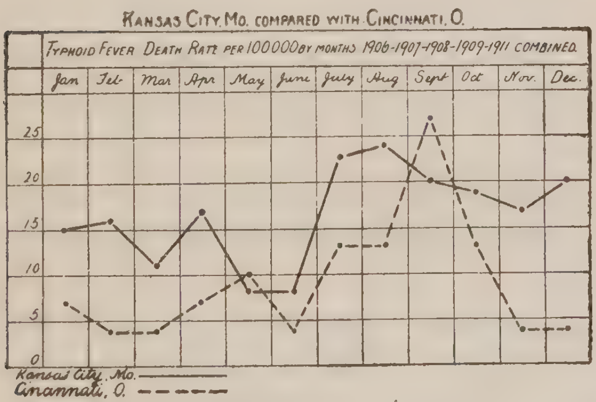


CHART 8.

BOONVILLE, MO.

Boonville is situated on the Missouri River 116 miles below Lexington and 184 miles below Kansas City. The population in 1910 was 4,252. About a third of the population still depend upon privies, although Boonville has several miles of sewerage discharging by two outlets into the Missouri River.

The water supply is from the Missouri River, treated. There is also total storage capacity in the three reservoirs of over 6,000,000 gallons. This would afford storage for about 12 days' supply. About one-third of the population depend upon wells, the remainder using the public water supply.

JEFFERSON CITY, MO.

Jefferson City, the capital of the State, is situated on the Missouri River, 54 miles below Boonville and 240 miles below Kansas City. The population in 1910 was 11,850.

The entire sewage of the city is discharged into the Missouri River. The waterworks intake is in the Missouri River above the sewer outlets. The raw water is treated with lime and iron sulphate with sedimentation. No hypochlorite was used up to the time of my inspection. Upon my request, Dr. M. C. Stone, State bacteriologist, made daily examinations from June 11 to June 29. The total bacteria counts ranged from 50 to 1,200, usually from 200 to 400. B. coli was present in all 1 c. c. samples except one, and was present once in the 0.01 c. c. sample. The writer advised the use of hypochlorite in a letter to Dr. Stone, July, 1912.

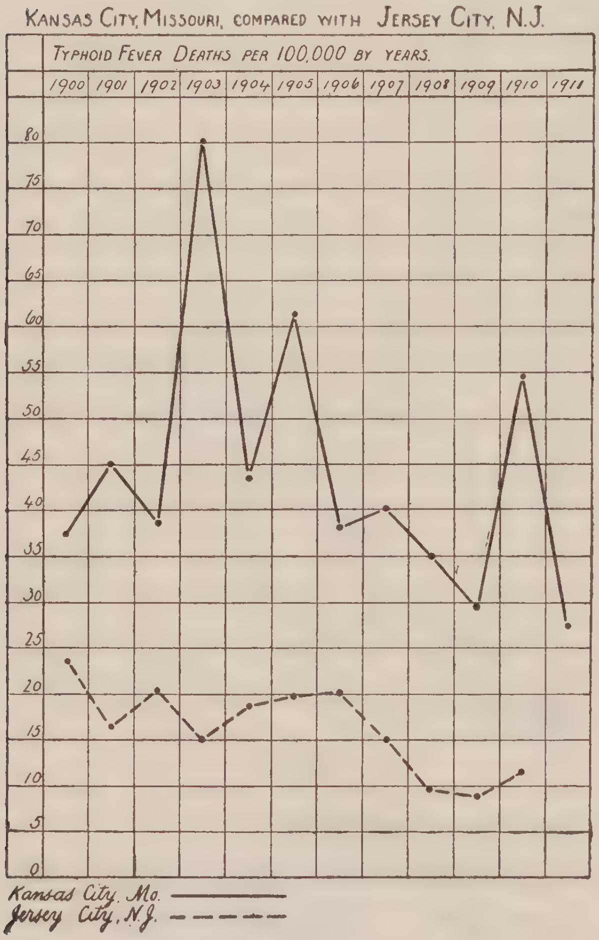


CHART 9.

WASHINGTON, MO.

Washington is situated on the Missouri River, 70 miles below Jefferson City and 38 miles below the mouth of the Osage River. Its population in 1910 was 3,670.

Two-thirds of the population use privies, the remaining third having sewer connections. There are about 2 miles of sewers emptying by one outlet into the Missouri River.

About a quarter of the population depend upon surface wells and the remainder use the public water supply. This is taken from the Missouri River. There is a reservoir capacity of 1,000,000 gallons, which should afford about five days' storage.

ST. CHARLES, MO.

St. Charles is situated on the Missouri River, 28 miles from its mouth and 43 miles below Washington. The population in 1910 was 9,437. About half the population use privies, although seven-eighths have

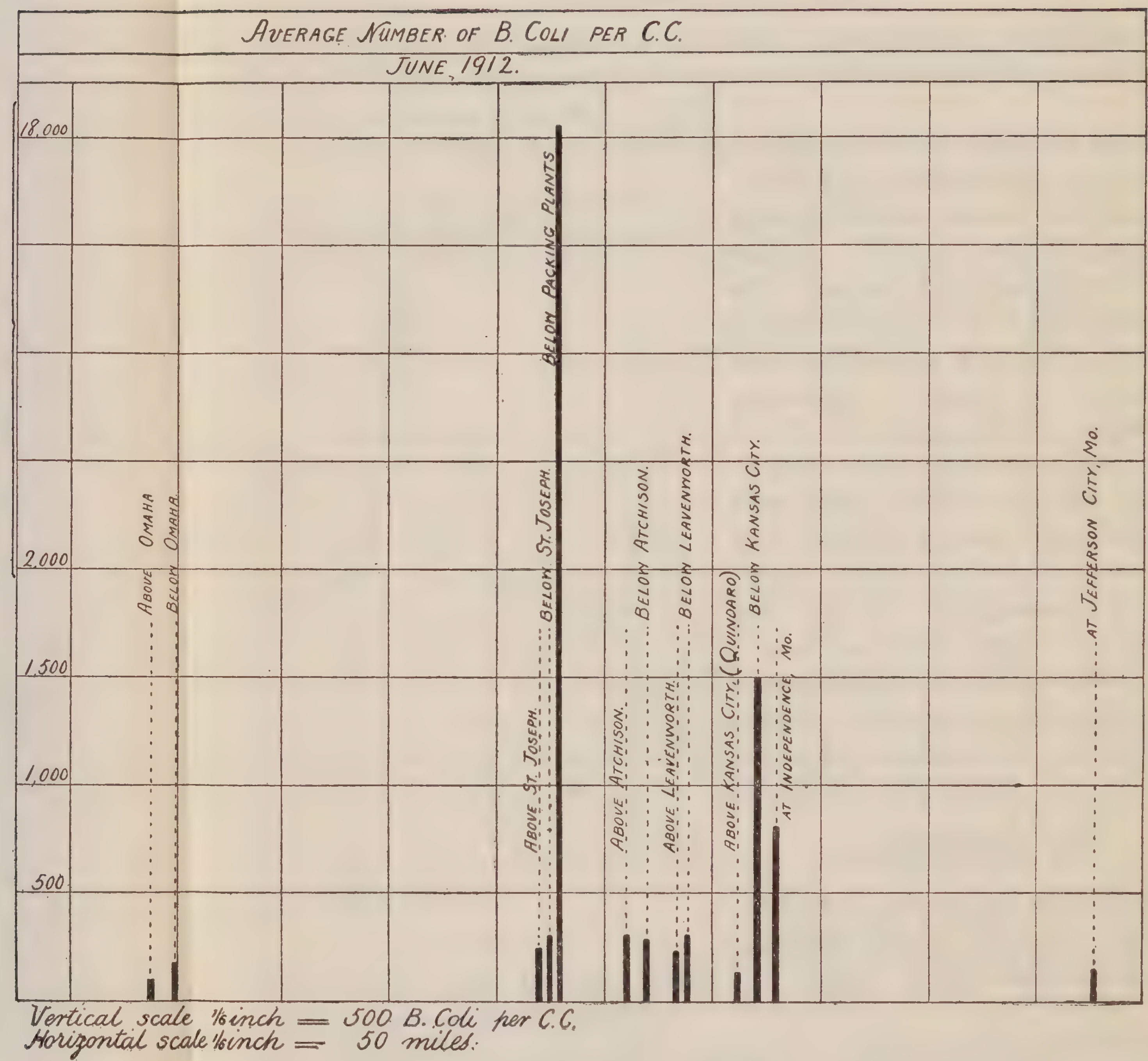


CHART 10.—Showing average number of B. coli per c. c. Missouri River during June, 1912.

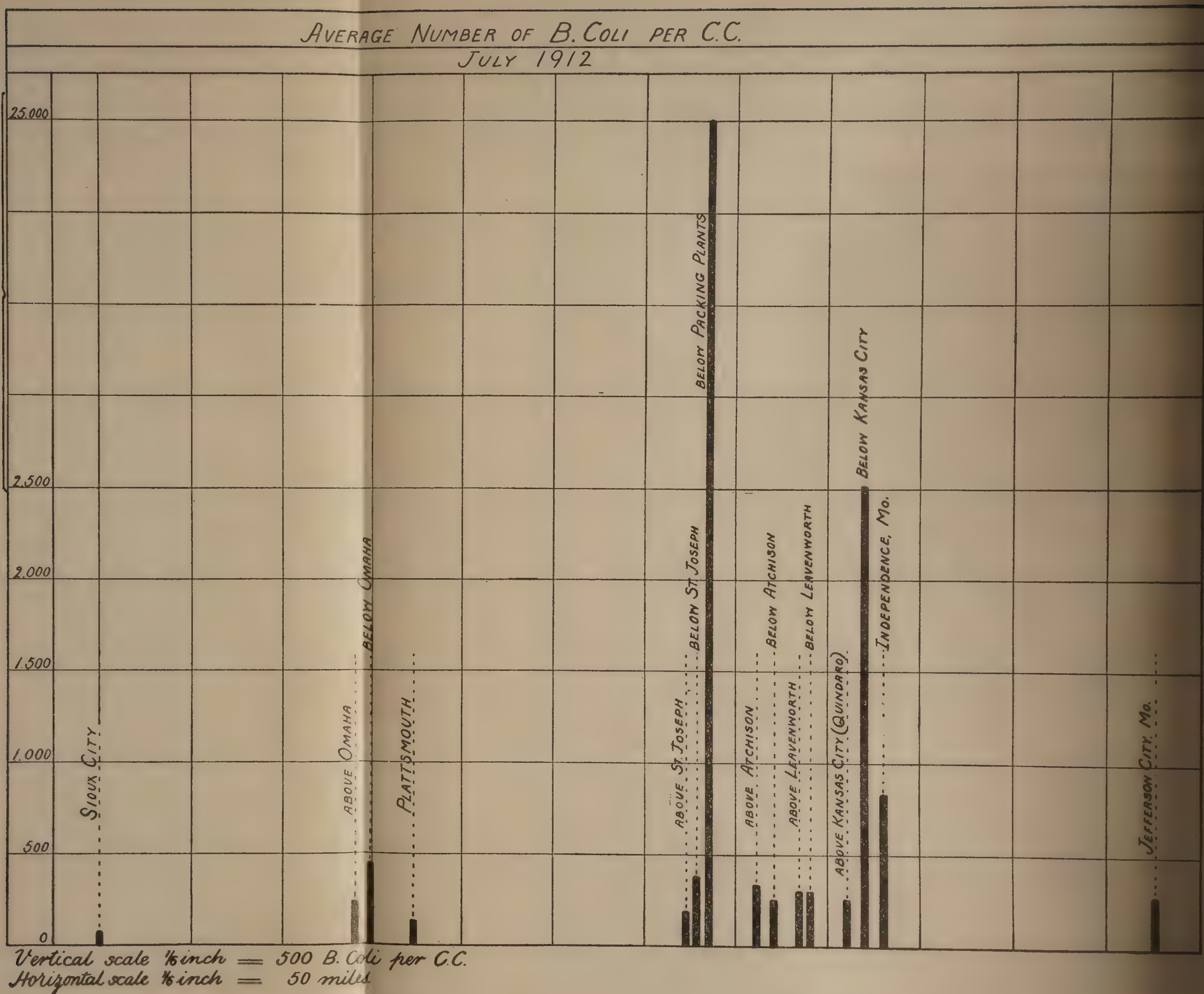


CHART 11.—Showing average number of B. coli per c. c. Missouri River during July, 1912.

91318°—13. (To face page 43.) No. 2.

access to sewers. There are about 15 miles of sanitary sewers, which discharge by two outlets into the Missouri River.

The public water supply is taken from the Missouri River and few wells are in use. There are three settling basins and one standpipe, and two additional reservoirs, each of 1,000,000 gallons' capacity, are to be constructed.

GENERAL SUMMARY.

(a) CONDITIONS.

There has been an undue prevalence of typhoid fever for years in every city taking its water supply from the Missouri River except St. Joseph, and St. Joseph had high rates in 1910 and 1911. The consistently high rates in winter and spring year after year indicate that the greatest factor in these high rates was the sewage-polluted Missouri River water, imperfectly purified.

Previous to 1910 the older systems of purification were ineffective in times of great turbidity or of high bacterial content. Sedimentation without the use of a coagulant is not sufficient to purify the Missouri River water in time of gross pollution.

Purification processes depending upon sedimentation are more effective in times of great turbidity, but this higher percentage of purification is nullified by the high initial bacterial content of the untreated water.

Sewage pollution of the lower Missouri River is general from Sioux City to its mouth, while it is greater in the vicinity of cities and packing plants. It is also marked at points on the river far removed from cities. At such points, after many miles of stream flow from the nearest urban source (54 miles at Jefferson City or 23 miles at Quindaro) the B. coli content is still as high as 150 to 300 per cubic centimeter during certain months. This necessitates a high degree of purification in order to make Missouri River water safe.

Filter plants have not been able at times to overcome the pollution of the Missouri, often for lack of sufficient sedimentation, but principally because of the lack of hypochlorite as a final process. The bacterial count and the B. coli content per cubic centimeter are at times so high in the Missouri River that with a filter efficiency of 98 per cent removed a dangerous effluent remains.

(b) REMEDIES.

The primary requisite to reduce the excessive prevalence of typhoid fever in this area is safe water supplies.

The addition of hypochlorite of lime as a finishing process to the existing purification plants seems to have produced good results in Omaha, Council Bluffs, St. Joseph, Leavenworth, and Kansas City, Mo. It is a question whether better results than those reported by Omaha and Kansas City, Mo., could be obtained by other methods. With a water of the character of Missouri River water, it is probable that the ideal is not reached by sedimentation and chemical treatment alone. Filtration would be an additional safeguard, and the increased cost could be further justified upon the improvement in the physical character of the water.

Kansas City, Kans., would be benefited by increased sedimentation basin capacity. Those cities which are not using hypochlorite should install a hypochlorite apparatus at once as an addition to their plants, after correcting the defects in their water purification systems. These municipalities need an aggressive campaign to eliminate the shallow well and the insanitary privy.

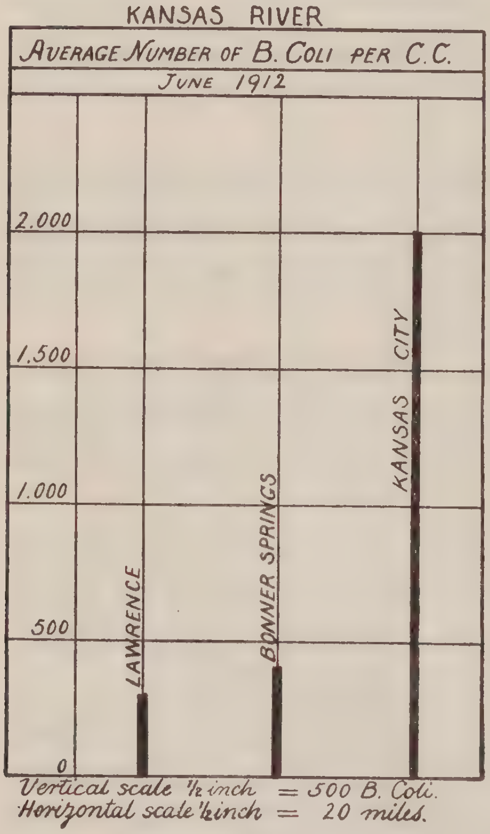


CHART 12.—Showing average number of B. coli per c. c. Kansas River during June, 1912.

Some pollution of streams in a populous area is inevitable. Even with the most elaborate methods of sewage treatment which are economically possible pollution will occur in times of flood after rains and thaws and from persons navigating the stream. Sewage treatment, as a matter of fact, has been initiated usually to prevent nuisance. It is very effective for this purpose by oxidizing the putrescible material or by the nitrification process due to anaerobes in septic compartments. The effluent, however, while it is more stable and less likely to produce nuisance, has still a very high bacterial content. So that sewage treatment is not a substitute for water purification.

The use of streams for the disposal of sewage is an economic resource and may often be employed without detriment to others; hence its absolute prohibition would be unjustifiable. Such use of streams is sound in principle and safe in practice when proper restrictive control is exercised.

Although prevention of all pollution is impossible, the control of pollution is feasible and necessary. The discharge of sewage by cities should be under control, and disposal by dilution should be permitted, for economic reasons, up to the limit of permissible pollution.

The permissible limit of pollution of a waterway can be fixed only after a careful study of the waterway, the uses which must be made of it and to which it is best adapted. The permissible limit of pollution allowing a reasonable use of the stream for the purposes for which it is best adapted must be fixed for each locality by the formulation of official standards for the waterway at that particular point. Such official standards should be made for each problem independently and separately, it being manifestly impossible to fix general standards of raw water to cover all cases without gross injustice. The acceptance of these basic facts will tend to prevent unjustifiable generalization in a problem in which each locality is a law unto itself. By allowing a reasonable use of these interstate waters for the reception of sewage or sewage effluents, subject to such restrictions coupled with water purification as will amply protect the public health, the more intensive process of sewage purification may in many cases be avoided. A city may thus be saved a very great expense which could only be justified on sentimental and not on practical grounds.

To attempt the impossible is not only to court certain failure, but, further, such attempts make difficult later efforts of a more conservative and practical nature.

The Missouri River at points farthest removed from the greatest sources of sewage pollution furnishes a raw water for drinking purposes which not only is unfit for drinking without treatment, but which requires very thorough treatment to render it safe.

Sewage treatment is often an aid and sometimes a necessity in improving the quality of a grossly polluted water which is used as a source of water supply. There is no doubt that there are points on the Missouri River where the pollution is excessive. This preliminary survey shows that some of these points have probably exceeded even a liberal construction of the phrase "permissible pollution." It is impossible to generalize with justice and a further intensive survey at such points is necessary to determine if treatment is necessary and what degree of purification should be exacted in fairness to all concerned.

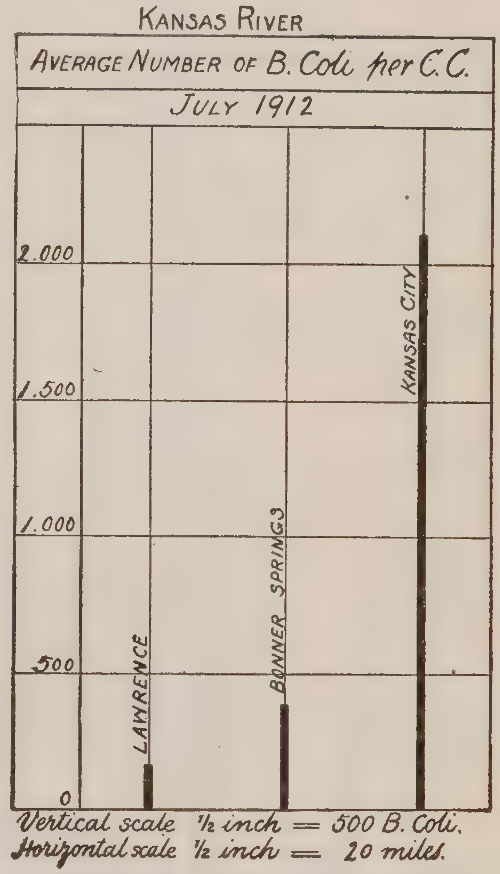


CHART 13.—Showing average number of B. coli per c. c. Kansas River during July, 1912.

The condition of the Missouri River has reached a point where immediate control of pollution is necessary to prevent further impairment of the stream as an interstate source of water supply. Probably restriction of the present pollution would be unnecessary except at certain points, but further increase of this pollution should be carefully passed upon and permission granted only after most careful consideration. If the pollution increases beyond present conditions too great a strain and responsibility will be placed upon the water-purification plants.

Even now the pollution is such that at certain points it would be an unfair adjustment of the balance between sewage treatment and water purification to expect any water-purification plant to care for such a raw water. Luckily it has not been necessary thus far to place water-works intakes near such points.

The pollution found in the Missouri River is sufficiently gross to require attention. Before the introduction of "hypochlorite" as a finishing process or adjuvant to other methods of water purification, one would have said unquestionably that the raw water in the Missouri River was polluted to such an extent that its purification imposed an excessive responsibility and undue cost upon purification plants, and therefore this pollution should be greatly reduced.

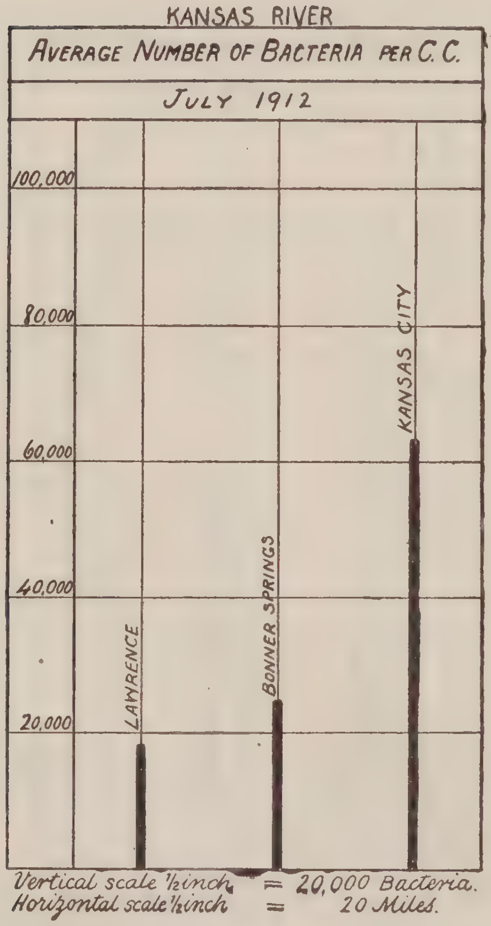


CHART 15.—Showing average number of bacteria per c. c. Kansas River during June, 1912.

A filter plant or a purification plant of any kind unaided by hypochlorite is considered to be working satisfactorily if the percentage removal of bacteria is as high as 99 per cent. Yet such efficiency applied to Missouri River water with counts of 50,000 or 100,000 leave a very dangerous effluent with bacterial counts of 500 to 1,000 per cubic centimeter.

The introduction of hypochlorite modified our views somewhat in regard to the load upon a purification plant which could be cared for economically. By the addition of hypochlorite to a clarified effluent, with counts of 500 or higher, a result bacteriologically satisfactory is obtained at low cost, as shown at Omaha, Kansas City, Mo., and other places. I am of the opinion, however, that the pollution of raw water used as a source for water-purification plants, should be reduced to the minimum consistent with the finances of the communities involved even where the purification plant plus the hypochlorite seems to be able to overcome the high bacterial counts and other indices of pollution in the raw water.

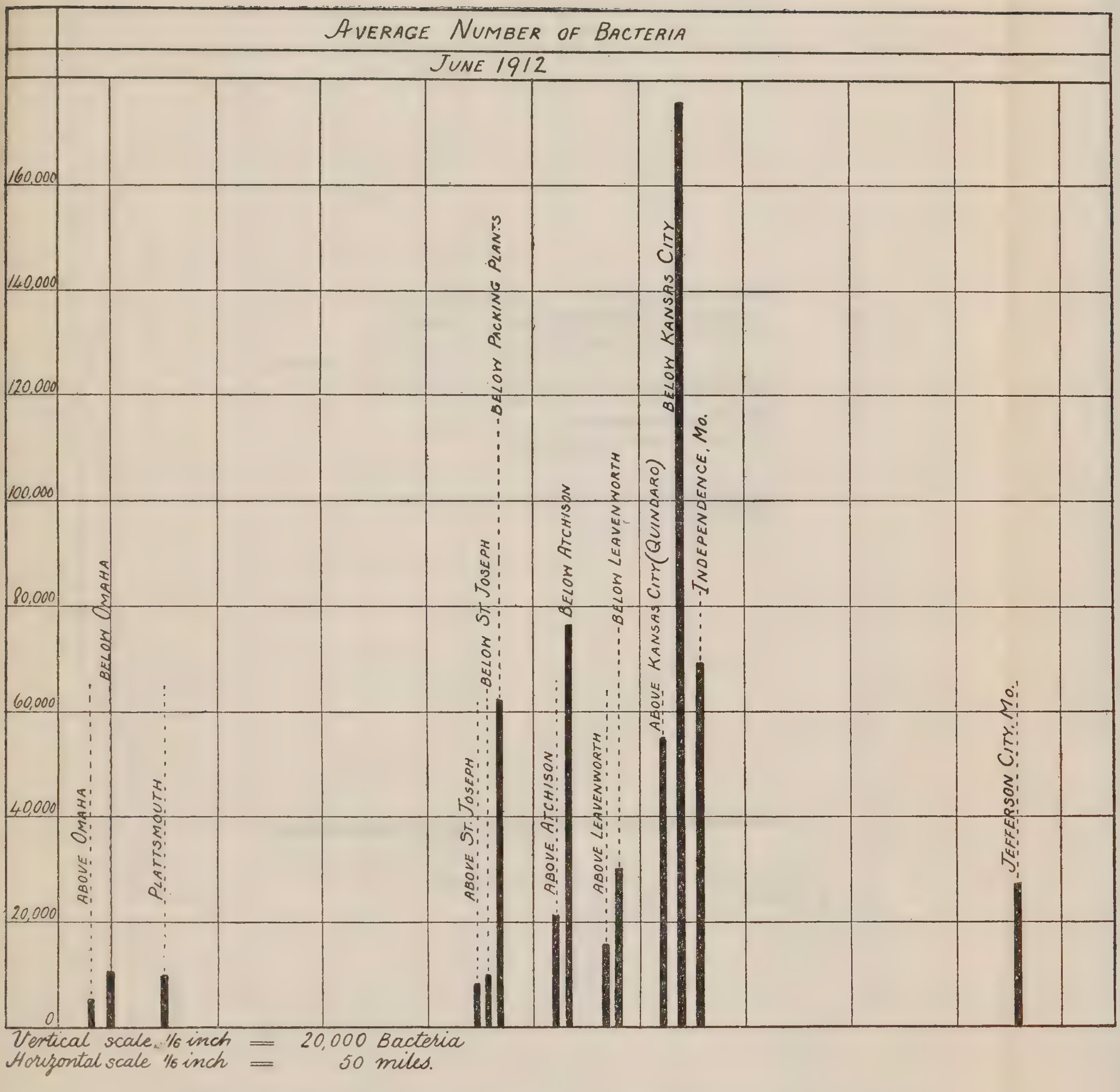


CHART 14.—Average number of bacteria per c. c. Missouri River during June, 1912.

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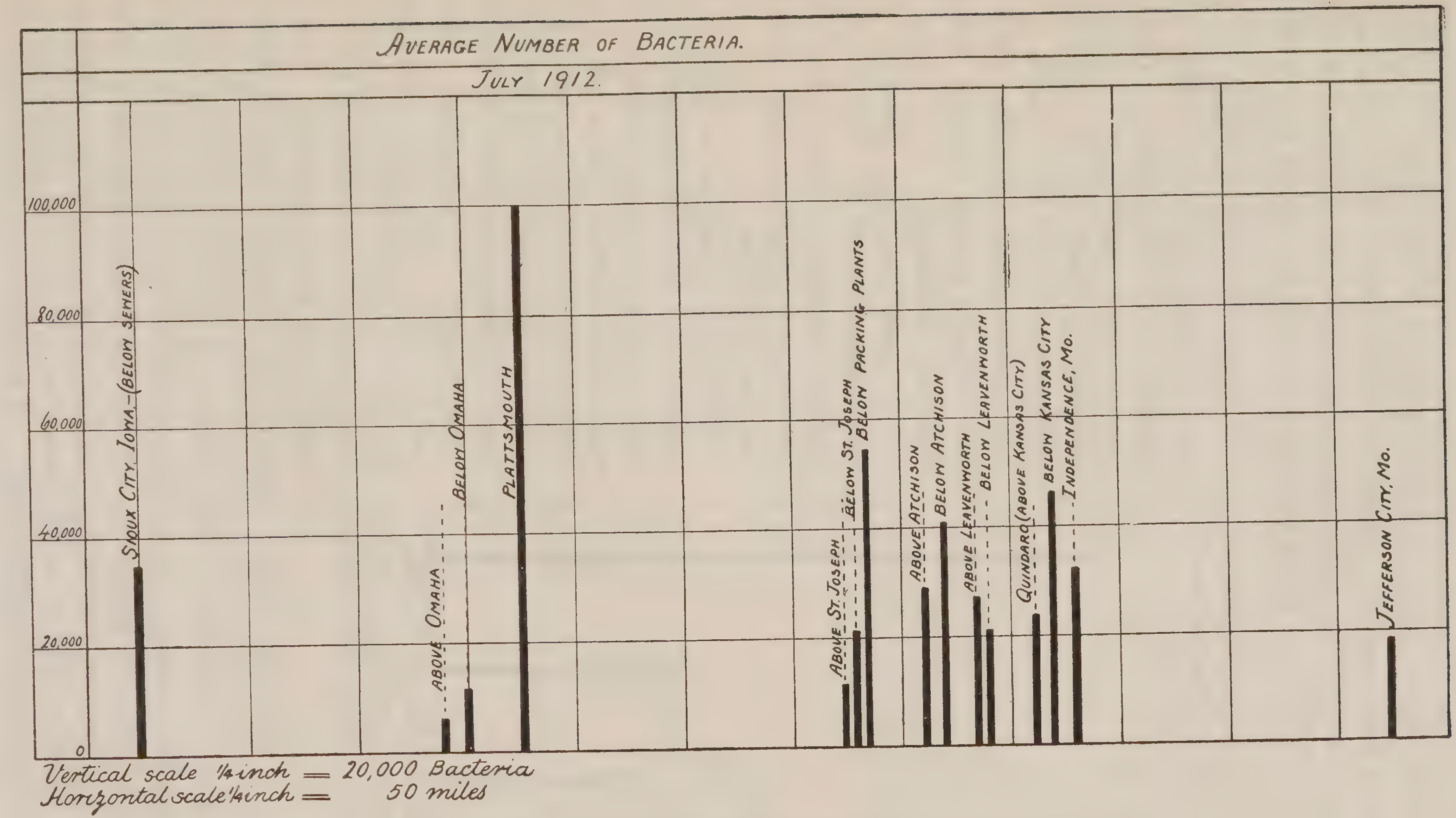

CHART 16.—Showing average number of bacteria per c. c. Missouri River during July, 1912.

The rather high degree or rural pollution—that is, washings of the drainage area in times of flood, thaws, and heavy rains—is unavoidable, but the heavy unrestrained pollution of many cities and towns on tributary streams is corrigible at least to some extent under State laws and such improvement should be effected. The urban pollution and pollution from packing plants is a very great factor in the pollution of the Missouri River, and this unrestrained discharge of raw sewage and wastes into the great interstate waterway should be checked and placed under most careful control.

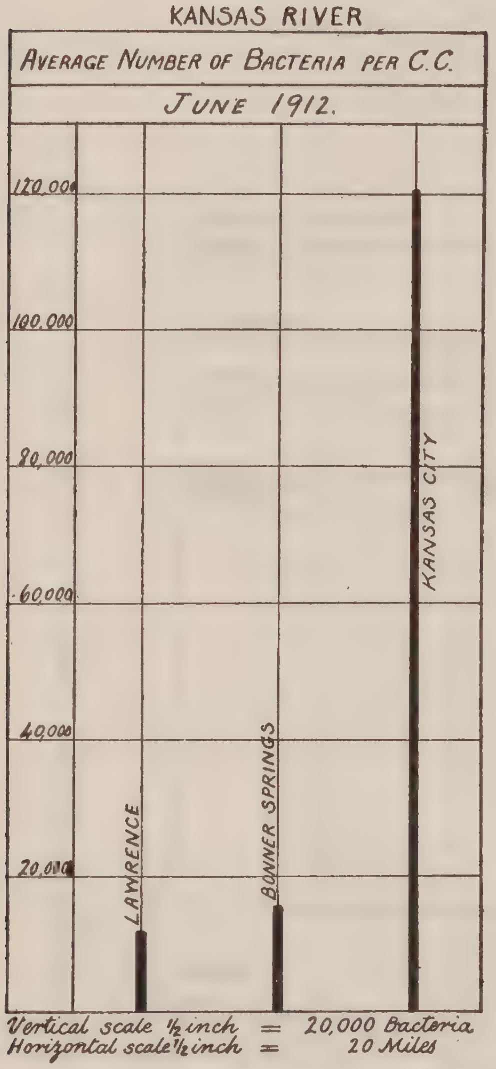

CHART 17.—Showing average number of bacteria per c. c., Kansas River during July, 1912.

In discussing the problem of pollution of waterways many widely diverse opinions are expressed. There are those on the one hand who speak of absolute prevention of pollution as though it were feasible to effect, while the opposite view is held by some, that the streams should receive the unrestricted discharge of sewage from urban communities. Between these two extremes lies the logical position held by students of the problem whose professional training and experience compels attention.

This latter position is held by sanitarians and sanitary engineers in general, and consists in control of pollution, using the streams wherever possible without detriment to the public health.

The pollution of rivers, streams, and lakes within a State may be controlled by State laws. The problem of the control of great interstate and international lakes and rivers is not so simple. They must be considered as a complete entity, and not piecemeal. The same laws or restrictions should apply to the Missouri River whether it be that part which separates Iowa and Nebraska, or that which separates Kansas and Missouri. The problem of pollution of interstate and international waters is so broad and affects so many interests that it necessitates for its equitable and efficient handling a central directing authority independent of local influences of prejudices. This central authority must also have the power to deal with foreign countries and adjust international differences. It is difficult to secure uniformity of law in the various States, and uniformity of procedure under such law is almost too much to be expected. To treat the problem of pollution on these great interstate or international waterways with justice and equity to all concerned there is a necessity for Federal control.

This control should include provisions that persons, corporations, or municipalities now habitually polluting an interstate waterway should be required to file within a specified period plans in duplicate showing the manner and extent of pollution. They should be required to secure a permit from the Federal authority for any extension of existing sewer or waste outlets or systems before commencing construction. The Federal requirements should be the minimum necessary for the prevention of the spread of disease in interstate traffic, leaving to the various States the right to exact more rigid requirements from municipalities within their own borders consistent with their own State laws.

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APPENDIX.

REPORT OF COMMITTEE ON STANDARDS OF PURITY FOR RIVERS AND WATERWAYS.

To the President and Members of the National Association for Preventing the Pollution of Rivers and Waterways:

GENTLEMEN: At a meeting of the National Association for Preventing the Pollution of Rivers and Waterways, held at Baltimore, Md., on December 13, 1911, it was voted "that a committee of five members of the association be appointed by the president to act as a committee on standards of purity for rivers and waterways, with instructions to study the general subject in a broad way, and to make a tentative report at the next annual meeting of the association on the feasibility of establishing standards applicable to different conditions," and on December 21, 1911, the undersigned were duly appointed by the president, Mr. Calvin W. Hendrick, to serve as members of this committee. We at once entered into correspondence and on June 27, 1912, met in New York for a conference.

The various matters involved have been considered in detail, but the present preliminary report is confined to certain fundamental propositions, about which there appears to be little difference of opinion among sanitary engineers. These propositions, with a few explanatory notes, are as follows:

Your committee finds—

(1) That because of the increasing population of the country, the increasing tendency toward concentration of population in cities, the extension of agriculture, the increasing necessity of artificial fertilization, and the growth of manufacturing, it is and always will be physically impossible to maintain our rivers and waterways in their original and natural condition of purity. However much we may strive to the contrary, some pollution of the water is inevitable. A reasonable degree of cleanliness should nevertheless be demanded.

(2) That up to certain limiting points the use of our rivers and waterways as vehicles for the reception, transmission, and ultimate disposal of sewage and other liquid wastes is primarily an economic question. The discharge of raw sewage into our streams and harbors should not be universally prohibited by law.

(3) That the method of disposal of sewage by dilution is recognized as sound in principle and safe in practice, if carried on with proper restrictions. The power of streams to transport suspended matter, and the ability of natural bodies of water to oxidize and destroy offensive substances through the action of various physical, chemical, and biological processes, represent a natural resource that should be utilized as far as this can be done with safety and economy and without offense.

NOTE.—This is in line with the present idea of conservation. It is believed that the use of these forces of nature may be just as valuable in their way as the use of certain streams for water power is valuable in its way. Not to take advantage of them where possible would be contrary to public economy. Some streams probably serve their best use to the general public as carriers and destroyers of waste organic matter. The point to be determined is as to how far these forces can be utilized without offense. The ordinary limits of dilution based on the ratio of the population or the volume of the sewage to the stream flow are not sufficient, as they fail to take into account the velocity of the current and the opportunities for aeration. Further data on this point are needed.

(4) That for each river and waterway at any given point there is a limit to the amount of permissible discharge of waste matter. The reasons for this limit are not the same in all cases, but vary according to the use that is made of the river or of the water of the river, and according to the character of the territory through which it flows. No universal standard of purity can be wisely established or maintained.

(5) That when the extent of the pollution is such as to affect the public health in any way by any reasonable use of the river or the water of the river, the sanitary aspect of the situation should control and the degree of pollution should be regulated accordingly.

Note.—This proposition involves the question as to what is a reasonable use of rivers and waterways, which is a matter to be determined for each particular case, and one that in the event of conflicts between different interests must at present be decided by the courts.

(6) That when the extent of the pollution is such as to cause sensible offense to public decency in the course of any reasonable use of the river, this aspect of the situation may properly control.

(7) That when the extent of pollution is such as to cause material injury to fish or shellfish industries, or to the ice industry, this element may control.

(8) That when the extent of the pollution is such as to cause the silting up of the channels of navigable streams, this element may control.

(9) That even when the demands of public health, offense to decency, and interference with navigation are such as to place a limit to the pollution of the stream, the economic aspects of the case should be considered in regulating the amount of permissible discharge of waste matter—the fundamental principle being that the results accomplished shall be reasonably commensurate with the cost of prevention of the pollution.

Note.—It is recognized that there are great demands upon cities for expenditures made in the interest of public health and comfort, and that the relative results obtained by expenditures for different purposes should be considered when budgets are being made up.

(10) That while no universal standard of purity applicable to all rivers and waterways can be established, it is believed to be feasible to establish and maintain appropriate standards of a general nature for waters that fall within certain particular groupings. Your committee has this matter under advisement, but is not prepared to report upon it in detail at this time.

(11) That, inasmuch as the safety of public water supplies is the most important element in the problem of stream pollution at the present time, the following general principles should govern the discharge of sewage and waste matters into rivers and waterways.

(*a*) Streams from which water supplies are taken without purification should not receive any fecal matter, sewage, sewage effluent, or wastes that will render the water a menace to health or otherwise impair its natural quality.

(*b*) Streams from which water supplies are taken and used after purification should not receive fecal matter, sewage, sewage effluent, or waste matters in such quantities that the contamination of the water at any waterworks intake would put an unreasonable burden upon the purification works, or in quantities sufficient to produce the conditions referred to in the next paragraph. The treatment of sewage or wastes required to produce this result may vary from none at all, in the case of large streams where the pollution is very remote, to a thorough treatment if the pollution is large and near the waterworks intake.

(*c*) Streams not used for water supply may receive sewage whereverand in such quantities that its entrance will not sensibly offend decency in the reasonable public use of the stream or cause interference with navigation or with valuable fish industries or the ice industry. Where this can not be done the sewage or wastes should receive such treatment before discharge as to bring the effluent within this rule, due regard being given to the relative cost of the processes required and the benefits to be derived.

(*d*) Large lakes from which water is used for a public water supply without filtration should not receive any fecal matter, sewage, or sewage effluent within a distance of several miles from the intake, depending upon local conditions as to currents, and suitable provision should be made for disinfecting the water supply.

(*e*) Large lakes from which water is used for public water supply after filtration should not receive fecal matter, sewage, sewage effluents, or other waste matters in such amounts or at such places that the water reaching the intake would be contaminated to the extent that an unreasonable load would be placed upon the filter, or in quantities sufficient to produce the conditions referred to in the next paragraph. The sewage treatment required to produce this result may vary in efficiency according to the distance between the sewer outlet and the water-supply intake, the nature of the currents, and other local factors.

(*f*) Lakes not used for water supply may receive sewage if discharged in such a manner as to be quickly and thoroughly diluted, so that its entrance will not sensibly offend decency in the reasonable use of the lake, or interfere with navigation or with valuable fish industries. Where this can not be done the sewage should receive such treatment before discharge as to bring the effluent within this rule, due regard being given to the relative cost of the processes required and the benefits to be derived.

(*g*) Harbors and tidal estuaries may receive sewage at such places and in such amounts that the discharge does not sensibly offend decency in the reasonable public use of the water or cause interference with navigation or with valuable fish or shellfish industries. Where this can not be done the sewage should receive such treatment before discharge as to bring the effluent within this rule, due regard being given to the relative cost of the processes required and the benefits to be derived.

Note.—The tenth proposition brings up the very important question as to what is a reasonable burden to place upon a water-filtration plant. The data for deciding this have not yet been secured. It is recognized that water-filtration plants are not infallible and that for this reason the work that they are called upon to do must not be too great. Until this fundamental question is settled it will not be possible to formulate reasonable standards of purity for streams necessarily used both for sewage disposal and for water supply. It is not out of place to here remark that often greater economy can be secured by abandoning water supplies from polluted streams than by attempting to reduce the pollution to the required extent. The difficulty in doing this lies in properly adjusting the cost between the conflicting interests and raises some interesting questions of the policy of control that might be properly taken up for discussion by another committee of this association.

(12) Thus while recognizing that the pollution of many rivers and waterways is inevitable, and that absolute prevention of pollution is impossible, it is deemed imperatively necessary that some control over the discharge of waste matter into rivers and waterways be maintained in order that conditions prejudicial to the public health and comfort and damage to property may be kept at a minimum. The committee heartily indorses, therefore, the movement that is being made to keep the pollution of streams within reasonable bounds and not allow our rivers and waterways to become unduly soiled.

Your committee recommends the adoption by the association of these fundamental propositions, believing that they will serve as a basis for the establishment of more detailed standards later, and will be helpful to those who at the present time are engaged in formulating policies in regard to this matter.

Your committee also requests that it be allowed to continue its work for another year, and that it be given power to confer with the committee on river cleaning recently chosen by the section of sanitary engineering of the American Pulbic Health

Association, and, if thought desirable, to collaborate with this committee in the formulation of a joint report.

George C. Whipple.
A. J. McLaughlin.
Edward Bartow.
George M. Wisner.
H. W. Clark.

New York, *October 22, 1912.*

Table I.

[Bacteriological laboratory, Iowa State Board of Health, Prof. Henry Albert, director.]

Date.	Sampling point 1, Missouri River, below Sioux City, Iowa.					
	Number of colonies in 1 c. c.	Colon bacilli found in—				
		10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 2	45,000	+	+	+	–	–
3	49,000	+	+	+	–	–
4 (no specimen)						
5	40,000	+	+	+	+	–
6	46,000	+	+	+	+	–
7 (no specimen)						
8	45,000	+	+	+	+	–
9	50,000	+	+	+	+	–
10	40,000	+	+	+	+	–
11	60,000	+	+	+	+	–
12	42,000	+	+	+	–	–
13	38,000	+	+	+	–	–
14 (no specimen)						
15	36,000	+	+	+	+	–
16	30,000	+	+	+	+	–
17	25,000	+	+	+	–	–
18	20,000	+	+	+	–	–
19	28,000	+	+	+	–	–
20	40,000	+	+	+	–	–
21 (no specimen)						
22	40,000	+	+	+	+	–
23	32,000	+	+	+	–	–
24	20,000	+	+	+	+	–
25	21,000	+	+	+	+	–
26	20,000	+	+	+	+	–
27	28,000	+	+	+	–	–
28 (no specimen)						
29	40,000	+	+	+	–	–
30	28,000	+	+	+	+	–
31	20,000	+	+	+	–	–

Table II.

[Laboratory, Omaha Department of Health, Prof. Millard Langfeld, bacteriologist.]

Date.	Sampling point 2, Missouri River, Omaha, Nebr., taken above city.					Sampling point 3, Missouri River, Omaha, Nebr., taken below city.				
	Bacteria in 1 c. c.	B. coli in—				Bacteria in 1 c. c.	B. coli in—			
		1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.		1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
June 1	4,000	+	+	+	–	12,000	+	+	–	–
2 (Sunday)										
3	3,800	+	–	–	–	12,200	+	+	+	–
4	3,200	+	+	–	–	2,800	+	+	+	–
5	2,600	+	+	–	–	3,800	+	+	+	–
6	7,000	+	+	–	–	17,000	+	+	–	–
7	7,200	+	+	+	–	12,000	+	+	+	+
8	3,000	+	+	–	–	15,000	+	+	+	–
9 (Sunday)										
10	7,400	+	+	–	–	9,600	+	+	+	–
11	4,000	+	+	+	–	13,600	+	+	–	–
12	26,600	+	+	+	–	9,200	+	+	–	–
13	10,400	+	+	+	+	13,200	+	+	+	–
14	7,000	+	+	–	–	18,400	+	+	+	–
15	3,200	+	+	+	–	4,200	+	+	+	–
16 (Sunday)										
17	6,800	+	+	–	–	10,800	+	+	+	–
18	2,800	+	+	+	–	6,000	+	+	+	–
19	4,800	+	+	+	–	3,300	+	+	+	–
20	4,200	+	+	–	–	7,200	+	+	–	–
21	3,800		+	+	–	8,600		+	+	–
22	2,000		+	–	–	7,400		+	+	–
23 (Sunday)										
24	1,600		+	+	–	7,000		+	+	–
25	2,200		+	–	–	3,800		+	+	–
26	4,400		+	+	–	5,800		+	+	+
27	1,000		+	–	–	(1)				
28	7,200		+	+	–	12,800		+	+	–
29	5,600		+	+	–	16,400		+	+	–
30 (Sunday)										

[1] No specimen.

Table III.

Date.	Sampling point 2, above city.					Sampling point 3, below city.				
	Bacteria in 1 c. c.	B. coli in—				Bacteria in 1 c. c.	B. coli in—			
		1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.		1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 1	9,400		+	+	+	24,400		+	+	+
2	3,600		+	+	–	17,800		+	+	+
3	7,100		+	+	+	14,400		+	+	+
4 (No specimen)										
5	5,100		+	+	–	14,300		+	+	+
6	3,200		+	+	–	13,600		+	+	–
7 (Sunday)										
8	8,500		+	+	–	14,200		+	+	+
9 (No specimen)										
10	4,900		+	+	–	12,300		+	+	–
11	3,600		+	+	–	14,000		+	+	–
12	3,800		+	–	–	4,000		+	–	–
13	1,800		+	+	–					
14 (Sunday)										
15	8,800		+	+	–	12,300		+	+	–
16	16,300		+	+	+	13,100		+	+	–
17	4,700		+	+	–	8,500		+	+	–
18	3,200		+	+	–	4,600		+	+	–
19	7,600		+	+	+	10,200		+	+	–
20	8,500		+	+	–	4,200		+	+	+
21 (Sunday)										
22	7,100		+	+	–	9,400		+	+	–
23	9,600		+	+	–	15,400		+	+	+
24	5,400		+	+	–	12,200		+	+	–
25	3,200		+	+	–	8,600		+	+	–
26	4,600		+	+	–	16,300		+	+	–
27 (No specimen)										
28 (Sunday)										
29	3,800		+	+	–	7,000		+	+	+
30	3,000		+	+	–	7,400		+	+	–
31	13,500		+	+	–	7,100		+	+	–

TABLE IV.

[University of Nebraska, Department of Bacteriology; Prof. H. H. Waite, Mr. John J. Putnam.]

Location.	Date.	Sampling point 4, Platte River above Plattsmouth, sampling point 5, Missouri River, below Plattsmouth.					
		Bacteria per cubic centimeter on agar 48 hours at 37.5 c.	B. coli in—				
			0.001 c. c.	0.01 c. c.	0 1 c. c.	1 c. c.	10 c. c.
	1912.						
Missouri River	June 21	1,400	....	....	....	+	+
Platte River	...do....	1,350	....	....	....	+	+
Missouri River	June 22	1,250	....	....	....	+	+
Platte River	...do.....	1,300	....	....	....	+	+
Missouri River	June 25	10,000	....	....	....	+	+
Platte River	...do.....	8,350	....	....	....	+	+
Missouri River	June 26	3,700	....	....	....	+	+
Platte River	...do.....	35,000	....	....	....	+	+
Missouri River	June 27	1,000	....	....	....	+	+
Platte River	...do.....	2,400	....	....	....	+	+
Missouri River	June 28	24,000	....	....	....	+	+
Platte River	...do.....	4,500	....	....	....	+	+
Missouri River	June 29	24,000	....	....	....	+	+
Platte River	...do.....	14,400	....	....	....	+	+
Missouri River	July 1	17,000	....	....	....	+	+
Platte River	...do.....	2,230	....	....	....	+	+
Missouri River	July 2	7,500	....	....	....	+	+
Platte River	...do.....	2,800	....	....	....	+	+
Missouri River	July 4	3,300	....	....	....	+	+
Platte River	...do.....	9,500	....	....	....	+	+
Missouri River	July 5	7,000	....	....	....	+	+
Platte River	...do.....	3,000	....	....	....	+	+
Missouri Rive	July 6	14,000	—	—	+	+	+
Platte River	...do.....	10,000	—	—	—	+	+
Missouri River	July 9	73,200	—	+	+	+	+
Platte River	...do.....	65,000	—	—	—	+	+
Missouri River	July 10	113,600	—	—	+	+	+
Platte River	...do.....	25,000	—	—	+	+	+
Missouri River	July 11	(1)	—	+	+	+	+
Platte River	...do.....	(1)	—	—	+	+	+
Missouri River	July 12	74,000	—	+	+	+	+
Platte River	...do....	77,000	—	+	+	+	+
Missouri River	July 13	25,000	—	—	+	+	+
Platte River	...do.....	35,000	—	+	+	+	+
Missouri River	July 15	80,000	—	—	+	+	+
Platte River	...do.....	27,000	—	+	+	+	+
Missouri River	July 16	75,000	—	—	+	+	+
Platte River	...do.....	58,000	—	+	+	+	+
Missouri River	July 17	625,000	—	—	+	+	+
Platte River	...do.....	225,000	—	—	+	+	+
Missouri River	July 18	248,000	—	+	+	+	+
Platte River	...do.....	153,000	—	—	+	+	+
Missouri River	July 19	125,000	—	+	+	+	+
Platte River	...do.....	80,000	—	—	+	+	+
Missouri River	July 20	260,000	+	+	+	+	+
Platte River	...do.....	3,000	—	—	+	+	+
Missouri River	July 22	200,000	—	+	+	+	+
Platte River	...do.....	14,500	—	—	—	—	+
Missouri River	July 23	76,000	—	—	+	+	+
Platte River	...do.....	2,500	—	+	+	+	+
Missouri River	July 24	38,000	—	—	+	+	+
Platte River	...do.....	1,000	—	—	—	—	+
Missouri River	July 26	40,000	—	+	+	+	+
Platte River	...do.....	1,200	—	—	+	+	+
Missouri River	July 27	60,000	—	+	+	+	+
Platte River	...do....	3,700	—	—	+	+	+
Missouri River	July 29	45,000	—	+	+	+	+
Platte River	...do.....	3,700	—	—	+	+	+
Missouri River	July 30	115,000	—	—	+	+	+
Platte River	...do.....	12,400	—	—	+	+	+
Missouri River	July 31	35,000	—	+	+	+	+
Platte River	...do.....	24,000	—	—	+	+	+

[1] Spreaders

Table V.

[Laboratory of Board of Health, St. Joseph, Mo., Dr. E. A. Logan, bacteriologist.]

Date.	Sampling point 6, Missouri River, above the city.							
	Total count per cubic centimeter.	B. coli in—						
		10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.	0.00001 c. c.
June 8	3,200	+	+	+	−	−	−	−
9	1,800	+	+	+	−	−	−	−
10	7,200	+	+	+	+	−	−	−
11	1,900	+	+	+	−	−	−	−
12	6,700	+	+	+	+	−	−	−
13	3,000	+	+	+	−	−	−	−
14	2,100	+	−	+	+	−	−	−
15	50,000	+	+	+	+	−	−	−
16	8,000	+	+	+	−	−	−	−
17	10,000	+	+	+	+	−	−	−
18	82,000	+	+	+	+	+	+	+
19	7,000	+	+	+	+	−	−	−
20	4,200	+	+	+	−	−	−	−
21	12,900	+	+	+	+	−	−	−
22	30,000	+	+	+	+	+	−	−
23	7,200	+	+	+	+	+	−	−
24	20,000	+	+	+	+	+	−	−
25	15,000	+	+	+	+	−	−	−
26	2,300	+	+	+	+	+	−	−
27	400	+	+	+	−	−	−	−
28	380	+	+	−	−	−	−	−
29	2,000	+	+	+	−	−	−	−
30	900	+	+	−	−	−	−	−
July 1	17,000	+	+	+	+	−	−	−
2	23,800	+	+	+	+	−	−	−
3	5,000	+	+	+	−	−	−	−
4	16,000	+	+	+	+	−	−	−
5	7,000	+	+	−	−	−	−	−
6	3,000	+	+	−	−	−	−	−
7	9,000	+	+	−	−	−	−	−
8	30,700	+	+	+	+	−	−	−
9	17,500	+	+	+	−	−	−	−
10	9,800	+	+	+	+	−	−	−
11	1,600	+	+	+	+	−	−	−
12	1,400	+	+	+	−	−	−	−
13	46,800	+	+	+	+	+	−	−
14	13,000	+	+	+	+	−	−	−
15	34,000	+	+	+	+	+	−	−
16	14,000	+	+	+	+	−	−	−
17	1,400	+	+	+	−	−	−	−
18	5,000	+	+	+	+	+	−	−
19	14,200	+	+	+	+	+	+	−
20	700	+	+	+	−	−	−	−
21	18,200	+	+	+	+	−	−	−
22	400	+	+	+	−	−	−	−
23	3,200	+	+	+	−	−	−	−
24	3,000	+	+	+	−	−	−	−
25	2,500	+	+	+	−	−	−	−
26	13,000	+	+	+	−	−	−	−
27	12,000	+	+	+	−	−	−	−
28	8,000	+	+	−	−	−	−	−
29	5,400	+	+	+	−	−	−	−
30	9,100	+	+	+	−	−	−	−
31	6,200	+	+	−	−	−	−	−

TABLE VI.

Date.	Sampling point 7, Missouri River, at St. Joseph, Mo. (Grand Island Bridge).							
	Total count.	B. coli in—						
		10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.	0.00001 c. c.
June 8	3,700	+	+	+	+	–	–	–
9	16,000	+	+	+	+	+	–	–
10	1,200	+	+	+	–	–	–	–
11	1,700	+	+	+	+	–	–	–
12	15,500	+	+	+	+	–	–	–
13	7,300	+	+	+	+	–	–	–
14	2,200	+	+	+	+	+	–	–
15	4,700	+	+	+	+	+	–	–
16	8,400	+	+	+	+	+	–	–
17	8,000	+	+	+	+	–	–	–
18	90,000	+	+	+	+	+	–	–
19	4,200	+	+	+	–	–	–	–
20	9,400	+	+	+	+	–	–	–
21	4,600	+	+	+	+	–	–	–
22	14,400	+	+	+	+	–	–	–
23	23,000	+	+	+	+	–	–	–
24	13,100	+	+	+	–	–	–	–
25	890	+	+	+	+	–	–	–
26	5,000	+	+	+	+	–	–	–
27	1,200	+	+	+	–	+	–	–
28	2,800	+	+	+	–	–	–	–
29	1,400	+	+	–	–	–	–	–
30	2,200	+	+	+	–	–	–	–
July 1	80,000	+	+	+	+	–	–	–
2	71,400	+	+	+	+	+	–	–
3	3,000	+	+	+	+	+	–	–
4	2,200	+	+	+	+	–	–	–
5	1,200	+	+	+	+	–	–	–
6	11,000	+	+	+	+	+	–	–
7	12,240	+	+	+	+	–	–	–
8	10,000	+	+	+	–	–	–	–
9	880	+	+	–	–	–	–	–
10	2,000	+	+	+	–	–	–	–
11	2,000	+	+	+	+	+	–	–
12	1,100	+	+	+	–	–	–	–
13	1,800	+	+	+	+	–	–	–
14	30,700	+	+	+	+	+	–	–
15	52,600	+	+	+	+	–	–	–
16	27,600	+	+	+	+	–	–	–
17	3,000	+	+	+	+	–	–	–
18	4,000	+	+	+	+	–	–	–
19	16,000	+	+	+	+	+	–	–
20	2,000	+	+	+	–	–	–	–
21	50,000	+	+	+	+	–	–	–
22	5,000	+	+	+	+	–	–	–
23	13,400	+	+	+	+	+	+	–
24	13,000	+	+	+	+	+	+	–
25	10,000	+	+	+	+	+	–	–
26	14,500	+	+	+	+	–	–	–
27	13,000	+	+	+	+	–	–	–
28	24,000	+	+	+	+	–	–	–
29	17,000	+	+	+	–	–	–	–
30	11,000	+	+	–	–	–	–	–
31	162,000	+	+	+	+	+	–	–

TABLE VII.

Date.	Sampling point 8, Missouri River, St. Joseph, Mo. (below packing plants).							
	Total count per cubic centimeter.	B. coli in—						
		10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.	0.00001 c. c.
June 8	80,000	+	+	+	+	+	+	−
9	111,000	+	+	+	+	+	+	−
10	54,000	+	+	+	+	+	+	−
11	65,200	+	+	+	+	+	+	−
12	50,000	+	+	+	+	+	−	−
13	380,000	+	+	+	+	+	+	+
14	54,000	+	+	+	+	+	+	−
15	36,600	+	+	+	+	−	−	−
16	44,000	+	+	+	+	−	−	−
17	16,000	+	+	+	+	+	+	−
18	87,650	+	+	+	+	+	−	−
19	9,300	+	+	+	+	−	−	−
20	33,000	+	+	+	+	+	+	−
21	19,900	+	+	+	+	+	+	−
22	33,500	+	+	+	+	+	+	−
23	84,000	+	+	+	+	+	+	+
24	50,000	+	+	+	+	+	+	+
25	36,000	+	+	+	+	+	+	−
26	100,000	+	+	+	+	+	+	−
27	8,800	+	+	+	+	+	−	−
28	10,700	+	+	+	+	+	+	−
29	86,000	+	+	+	+	+	+	−
30	14,000	+	+	+	+	+	−	−
July 1	56,000	+	+	+	+	+	−	−
2	100,000	+	+	+	+	+	−	−
3	30,000	+	+	+	+	+	+	−
4	220,000	+	+	+	+	+	+	+
5	40,000	+	+	+	+	+	−	−
6	300,000	+	+	+	+	+	+	+
7	14,000	+	+	+	+	+	−	−
8	96,000	+	+	+	+	+	−	−
9	1,700	+	+	+	+	−	−	−
10	30,000	+	+	+	+	+	+	+
11	40,000	+	+	+	+	+	+	+
12	84,000	+	+	+	+	+	−	−
13	126,000	+	+	+	+	+	+	−
14	94,000	+	+	+	+	+	−	−
15	30,000	+	+	+	+	+	+	−
16	20,000	+	+	+	+	+	+	−
17	14,000	+	+	+	+	+	+	−
18	11,000	+	+	+	+	+	−	−
19	20,000	+	+	+	+	−	−	−
20	9,600	+	+	+	−	−	−	−
21	25,000	+	+	+	+	+	−	−
22	30,000	+	+	+	+	+	+	+
23	50,000	+	+	+	+	+	+	−
24	30,000	+	+	+	+	+	−	−
25	18,000	+	+	+	+	+	−	−
26	14,500	+	+	+	+	+	+	−
27	22,000	+	+	+	+	+	−	−
28	Spoiled.	+	+	+	+	+	+	+
29	30,000	+	+	+	+	+	+	+
30	54,000	+	+	+	+	+	+	−
31	28,000	+	+	+	+	+	−	−

Table VIII.

[Kansas State Board of Health Water and Sewage Laboratory University of Kansas, Lawrence, Kans. Mr. Sherwood, Miss M. Greenfield.]

Date.	Sampling points 9 and 10, Atchison, Kans.							
	Source.[1]	Bacteria.	Gas, acid col.	B. coli in—				
				10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
June 13	A. C.	50,000	Gas	+	+	+	+	−
			Acid col.	+	+	+	?	......
13	B. C.	457,000	Gas	+	+	+	+	−
			Acid col.	+	+	?	+	......
13	C. S.	90	Gas	+	−	−	−	−
			Acid col.	?	......	......	......	......
14	A. C.	32,200	Gas	......	+	+	−	+
			Acid col.	......	+	+	......	−
14	B. C.	338,000	Gas	......	+	+	+	+
			Acid col.	......	+	+	+	+
14	C. S.	10,000	Gas	+	......	−	−	......
			Acid col.	−	......	......	......	......
15	A. C.	16,000	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
15	B. C.	16,400	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
15	C. S.	400	Gas	+	−	−	−	......
			Acid col.	−	......	......	......	......
18	A. C.	19,500	Gas	......	+	+	+	−
			Acid col.	......	−	+	+	......
18	B. C.	20,000	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
18	C. S.	200	Gas	......	+	+	+	......
			Acid col.	......	+	+	+	......
19	A. C.	8,800	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
19	B. C.	13,000	Gas	......	+	+	+	+
			Acid col.	......	+	+	+	+
19	C. S.	290	Gas	+	+	+	+	......
			Acid col.	+	+	+	+	......
20	A. C.	11,200	Gas	......	+	+	+	−
			Acid col.	......	+	+	−	......
20	B. C.	6,600	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
20	C. S.	145	Gas	+	+	−	−	......
			Acid col.	+	+	......	......	......
22	A. C.	80,000	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
22	B. C.	82,000	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
22	C. S.	60	Gas	−	−	−	−	......
			Acid col.	......	......	......	......	......
24	A. C.	12,300	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
24	B. C.	10,000	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
24	C. S.	170	Gas	+	+	+	−	......
			Acid col.	−	+	+	......	......
25	A. C.	12,300	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
25	B. C.	6,400	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
25	C. S.	120	Gas	+	+	−	−	......
			Acid col.	+	+	......	......	......
26	A. C.	2,300	Gas	......	+	+	+	+
			Acid col.	......	+	+	+	+
26	B. C.	4,000	Gas	......	+	+	+	+
			Acid col.	......	+	+	+	+
26	C. S.	120	Gas	+	−	−	−	......
			Acid col.	+	......	......	......	......
27	A. C.	13,000	Gas	......	+	+	−	+
			Acid col.	......	+	+	......	+
27	B. C.	8,000	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
27	C. S.	20	Gas	+	+	−	−	......
			Acid col.	+	+	......	......	......
28	A. C.	5,400	Gas	......	+	+	+	−
			Acid col.	......	+	+	+	......
28	B. C.	7,900	Gas	......	+	+	−	−
			Acid col.	......	+	+	......	......

[1] A. C. signifies above the city; B. C. signifies below the city; and C. S. is the city water supply.

TABLE VIII—Continued.

Date.	Sampling points 9 and 10, Atchison, Kans.							
	Source.	Bacteria.	Gas, acid col.	B. coli in-				
				10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
June 28	C. S.	165	Gas	+	+	−	+	....
			Acid col.	+	+	....	−	....
29	A. C.	15,800	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
29	B. C.	16,900	Gas	....	+	+	−	+
			Acid col.	....	+	+	....	+
29	C. S.	140	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
July 1	A. C.	24,300	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	−
1	B. C	33,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
1	C. S.	11,600	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
2	A. C.	20,700	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
2	B. C.	57,700	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
2	C. S.	287	Gas	+	+	−	−	....
			Acid col.	+	+	....	....	....
3	A. C.	129,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
3	B. C.	143,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
3	C. S.	390	Gas	+	+	+	+	....
			Acid col.	+	+	+	+	....
5	A. C.	85,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	−	....
5	B. C.	126,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	−
5	C. S.	2,800	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
6	A. C.	25,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
6	B. C.	38,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
6	C. S.	380	Gas	+	+	−	+	....
			Acid col.	+	+	....	−	....
8	A. C.	35,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
8	B. C.	43,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
8	C. S.	530	Gas	+	+	−	+	....
			Acid col.	+	+	....	+	....
9	A. C.	18,400	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
9	B. C.	Spreader.	Gas	....	+	+	−	−
			Acid col.	....	+	+	....	....
9	C. S.	300	Gas	+	+	+	−	....
			Acid col.	+	+	+	....	....
10	A. C.	29,500	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
10	B. C.	30,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
10	C. S.	300	Gas	+	+	+	−	....
			Acid col.	+	+	+	....	....
11	A. C.	14,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
11	B. C.	86,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
11	C. S.	600	Gas	+	+	+	−	....
			Acid col.	+	+	+	....	....
12	A. C.	18,200	Gas	....	+	+	−	−
			Acid col.	....	+	+	....	....
12	B. C.	28,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
12	C. S.	Spreader.	Gas	+	+	+	−	....
			Acid col.	+	+	+	....	....
13	A. C.	5,600	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
13	B. C.	3,200	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
13	C. S.	(1)	Gas	....	....	....	....	....

[1] Bottle empty.

TABLE VIII—Continued.

Date.	Sampling points 9 and 10, Atchison, Kans.							
	Source.	Bacteria.	Gas, acid col.	B. coli in—				
				10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 15	A. C	7,300	Gas	......	+	+	+	+
			Acid col	......	+	+	+	+
15	B. C	11,000	Gas	......	+	+	+	+
			Acid col	......	+	+	+	+
15	C. S	1,100	Gas	+	+	+	−	......
			Acid col	+	+	+	......	......
16	A. C	15,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
16	B. C	10,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
16	C. S	1, 0	Gas	+	+	+	−	......
			Acid col	+	+	+	......	......
17	A. C	(1)						
17	B. C	7,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
17	C. S	700	Gas	+	−	−	−	......
			Acid col	+	......	......	......	......
18	A. C	(2)						
18	B. C	26,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
18	C. S	1,100	Gas	+	+	−	−	......
			Acid col	+	+	......	......	......
19	A. C	12,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
19	B. C	20,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
19	C. S	Broken.						
20	A. C	5,000	Gas	......	+	+	+	+
			Acid col	......	+	+	+	+
20	B. C	9,700	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
20	C. S	180	Gas	+	+	−	−	......
			Acid col	+	+	......	......	......
22	A. C	16,200	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
22	B. C	(3)						
22	C. S	1,400	Gas	+	+	+	−	......
			Acid col	+	+	+	......	......
23	A. C	84,000	Gas	......	+	+	+	+
			Acid col	......	+	+	+	+
23	B. C	90,000	Gas	......	+	+	+	+
			Acid col	......	+	+	+	+
23	C. S	620	Gas	+	+	−	−	......
			Acid col	+	+	......	......	......
24	A. C	7,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
24	B. C	(3)						
24	C. S	520	Gas	+	+	+	−	......
			Acid col	+	+	+	......	......
25	A. C	17,600	Gas	......	+	+	+	+
			Acid col	......	+	+	+	+
25	B. C	7,800	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
25	C. S	1,800	Gas	+	+	+	+	......
			Acid col	+	+	−	−	......
26	A. C	14,800	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
26	B. C	23,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
26	C. S	770	Gas	+	+	+	−	......
			Acid col	+	+	+	......	......
27	A. C	79,000	Gas	......	+	+	−	−
			Acid col	......	+	+	......	......
27	B. C	65,000	Gas	......	+	+	−	−
			Acid col	......	+	+	......	......
27	C. S	800	Gas	+	+	−	−	......
			Acid col	+	+	......	......	......
30	A. C	7,500	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
30	B. C	8,600	Gas	......	+	−	+	−
			Acid col	......	+	......	−	......
30	C. S	170	Gas	+	+	−	−	......
			Acid col	+	+	......	......	......
31	A. C	11,000	Gas	......	+	+	+	−
			Acid col	......	+	+	+	......
31	B. C	(3)						
31	C. S	......	Gas	+	+	+	−	......
			Acid col	+	+	+	......	......

[1] Sample broken. [2] Sample bottle broken. [3] Bottle broken.

TABLE IX.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans., Mr. Sherwood, Miss M. Greenfield.]

Date.	Sampling points 11 and 12, Leavenworth, Kans.							
	Source.[1]	Bacteria.	B. coli in—					
			Gas, acid col.	10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
June 11	A. C.	6,400	Gas	+	+	+	−	−
			Acid col.	+	+	+	.....	.....
11	B. C.	145,000	Gas	+	+	+	+	+
			Acid col.	+	+	+	+	+
11	C. S.	.....	.....	.....	.....	.....	.....	.....
12	A. C.	1,400	Gas	+	+	+	+	+
			Acid col.	+	+	+	+	+
12	B. C.	100,000	Gas	+	+	+	−	−
			Acid col.	+	+	+	.....	.....
12	C. S.	.....	.....	.....	.....	.....	.....	.....
13	A. C.	9,700	Gas	+	+	+	+	+
			Acid col.	+	+	+	+	+
13	B. C.	14,000	Gas	+	+	+	+	−
			Acid col.	+	+	+	+	.....
13	C. S.	50	Gas	−	−	−	−	−
			Acid col.	.....	.....	.....	.....	.....
14	A. C.	16,400	Gas	+	+	+	+	−
			Acid col.	+	+	+	−	.....
14	B. C.	12,000	Gas	+	+	+	−	−
			Acid col.	+	+	+	.....	.....
14	C. S.	340	Gas	−	−	−	−	−
			Acid col.	.....	.....	.....	.....	.....
15	A. C.	9,400	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
15	B. C.	16,600	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
15	C. S.	15,000	Gas	−	−	−	.....	.....
			Acid col.	.....	.....	.....	.....	.....
17	A. C.	73,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
17	B. C.	52,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
17	C. S.	15	Gas	+	−	−	−	.....
			Acid col.	+	.....	.....	.....	.....
18	A. C.	30,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	−	.....
18	B. C.	60,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
18	C. S.	50	Gas	−	−	−	−	.....
			Acid col.	.....	.....	.....	.....	.....
19	A. C.	20,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
19	B. C.	19,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
19	C. S.	80	Gas	−	−	−	−	.....
			Acid col.	.....	.....	.....	.....	.....
20	A. C.	12,000	Gas	.....	+	+	+	+
			Acid col.	.....	+	+	+	+
20	B. C.	13,600	Gas	.....	+	+	+	+
			Acid col.	.....	+	+	+	+
20	C. S.	15	Gas	−	−	−	−	.....
			Acid col.	.....	.....	.....	.....	.....
21	A. C.	21,500	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
21	B. C.	18,200	Gas	.....	+	+	+	+
			Acid col.	.....	+	+	+	+
21	C. S.	12	Gas	−	−	−	−	.....
			Acid col.	.....	.....	.....	.....	.....
22	A. C.	12,400	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	+	.....
22	B. C.	13,000	Gas	.....	+	+	+	+
			Acid col.	.....	+	+	+	−
22	C. S.	40	Gas	−	−	−	−	.....
			Acid col.	.....	.....	.....	.....	.....
24	A. C.	9,800	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	−	.....
24	B. C.	7,000	Gas	.....	+	+	+	−
			Acid col.	.....	+	+	−	.....
24	C. S.	35	Gas	−	−	−	−	.....
			Acid col.	.....	.....	.....	.....	.....

[1] A. C. signifies above the city; B. C., below the city; and C. S. is the city water supply.

TABLE IX—Continued.

Date.	Sampling points 11 and 12, Leavenworth, Kans.							
	Source.	Bacteria.	B. coli in—					
			Gas, acid col.	10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
June 25	A. C.	7,800	Gas		+	+	+	–
			Acid col.		+	+	+	
25	B. C.	8,000	Gas		+	+	+	–
			Acid col.		+	+	+	
25	C. S.	7	Gas	–	–	–	–	
			Acid col.					
26	A. C.	7,800	Gas		+	+	–	–
			Acid col.		+	+		
26	B. C.	4,800	Gas		+	+	+	–
			Acid col.		+	+	+	
26	C. S.	10	Gas	–	–	–	–	
			Acid col.					
27	A. C.	8,100	Gas		+	+	–	–
			Acid col.		+	+		
27	B. C.	6,900	Gas		+	+	+	–
			Acid col.		+	+	+	
27	C. S.	10	Gas	–	–	–	–	
			Acid col.					
28	A. C.	10,200	Gas		+	+	–	–
			Acid col.		+	+		
28	B. C.	16,200	Gas		+	+	+	–
			Acid col.		+	+	+	
28	C. S.	8	Gas	–	–	–	–	
			Acid col.					
29	A. C.	18,000	Gas		+	+	+	–
			Acid col.		+	+	+	
29	B. C.	20,000	Gas		+	+	+	–
			Acid col.		+	+	–	
29	C. S.	110	Gas	+	–	–	–	
			Acid col.	+				
July 1	A. C.	17,300	Gas		+	+	+	–
			Acid col.		+	+	+	
1	B. C.	[1]						
1	C. S.	28	Gas	–	+	–	–	
			Acid col.		–			
2	A. C.	32,000	Gas		+	+	+	–
			Acid col.		+	+	+	
2	B. C.	73,000	Gas		+	+	+	+
			Acid col.		+	+	+	+
2	C. S.	10	Gas	–	–	–	–	
			Acid col.					
3	A. C.	17,600	Gas		+	+	+	–
			Acid col.		+	+	+	
3	B. C.	15,300	Gas		+	+	+	–
			Acid col.		+	+	+	
3	C. S.	37	Gas	–	–	–	–	
			Acid col.					
5	A. C.	80,000	Gas		+	+	+	–
			Acid col.		+	+	–	
5	B. C.	30,000	Gas		+	+	–	+
			Acid col.		–	+		–
5	C. S.	40	Gas	–	–	–	–	
			Acid col.					
6	A. C.	20,000	Gas		+	+	+	+
			Acid col.		+	+	+	+
6	B. C.	16,000	Gas		+	+	+	–
			Acid col.		+	–	+	
8	A. C.	15,300	Gas		+	+	+	+
			Acid col.		+	+	+	+
8	B. C.	27,400	Gas		+	+	+	+
			Acid col.		+	+	+	+
8	C. S.	20	Gas	–	–	–	–	
			Acid col.					
9	A. C.	12,000	Gas		+	+	+	–
			Acid col.		+	+	+	
9	B. C.	14,000	Gas		+	+	+	–
			Acid col.		+	+	+	
9	C. S.	6	Gas	+	–	–	–	
			Acid col.	+				
10	A. C.	42,000	Gas		+	+	+	+
			Acid col.		+	+	+	+
10	B. C.	22,000	Gas		+	+	+	–
			Acid col.		+	+	+	

[1] No sample.

TABLE IX—Continued.

Date.	Sampling points 11 and 12, Leavenworth, Kans.							
	Source.	Bacteria.	B. coli in—					
			Gas, acid col.	10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 10	C. S.	20	Gas	−	−	−	−	....
			Acid col.	....	....	....	....	....
11	A. C.	83,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
11	B. C.	1,250,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
11	C. S.	50	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
12	A. C.	50,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
12	B. C.	39,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
12	C. S.	Spreader.	Gas	+	+	−	−	....
			Acid col.	+	+	....	....	....
13	A. C.	8,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
13	B. C.	9,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
13	C. S.	20	Gas	−	−	−	−	....
			Acid col.	....	....	....	....	....
15	A. C.	6,700	Gas	....	+	+	−	−
			Acid col.	....	+	+	....	....
15	B. C.	7,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
15	C. S.	25	Gas	−	−	−	−	....
			Acid col.	....	....	....	....	....
16	A. C.	9,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
16	B. C.	12,500	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
16	C. S.	140	Gas	−	−	−	−	....
			Acid col.	....	....	....	....	....
17	A. C.	8,700	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
17	B. C.	10,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
17	C. S.	8	Gas	−	−	−	−	....
			Acid col.	....	....	....	....	....
18	A. C.	25,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
18	B. C.	28,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
18	C. S.	300	Gas	−	−	−	−	....
			Acid col.	....	....	....	....	....
19	A. C.	12,600	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
19	B. C.	16,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
19	C. S.	200,000	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
20	A. C.	10,600	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
20	B. C.	11,500	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
20	C. S.	21	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
22	A. C.	Broken.		....	....	....	....	....
22	B. C.	9,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
22	C. S.	10	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
23	A. C.	22,400	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
23	B. C.	29,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
23	C. S.	60	Gas	+	−	−	−	....
			Acid col.	+	....	....	....	....
24	A. C.	7,400	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
24	B. C.	8,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
24	C. S.	12	Gas	+	−	−	....	....
			Acid col.	+	....	....	....	....

TABLE IX—Continued.

Date.	Sampling points 11 and 12, Leavenworth, Kans.							
	Source.	Bacteria.	B. coli in—					
			Gas, acid col.	10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 25	A. C.	10,700	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
25	B. C.	11,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
25	C. S.	200	Gas	+	−	−	....	....
			Acid col.	+	....	....	....	....
26	A. C.	26,000	Gas	....	+	+	−	−
			Acid col.	....	+	+	....	....
26	B. C.	18,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
26	C. S.	Broken.	....	....	....	....	....	....
27	A. C.	27,000	Gas	....	+	+	−	−
			Acid col.	....	+	+	....	....
27	B. C.	65,000	Gas	....	+	+	−	−
			Acid col.	....	+	+	....	....
27	C. S.	1,200	Gas	−	−	−	....	....
			Acid col.	....	....	....	....	....
29	A. C.	8,600	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
29	B. C.	6,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
29	C. S.	500	Gas	+	+	−	−	....
			Acid col.	+	+	....	....	....
30	A. C.	105,000	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
30	B. C.	18,500	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
30	C. S.	30	Gas	−	−	−	....	....
			Acid col.	....	....	....	....	....
31	A. C.	34,000	Gas	....	+	+	+	−
			Acid col.	....	+	+	+	....
31	B. C.	15,200	Gas	....	+	+	+	+
			Acid col.	....	+	+	+	+
31	C. S.	Spreader.	Gas	−	−	−	....	....
			Acid col.	....	....	....	....	....

TABLE X.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans.; Mr. Sherwood, Miss M. Greenfield.]

Date.	Sampling point 13, Kansas River, at Lawrence, from bridge.						
	Bacteria.	Gas, acid col.	10 c. c.	1 c. c.	0.1 c. c	0.01 c. c.	0.001 c. c.
June 10	3,100	Gas	+	+	+	+	—
		Acid col.	+	+	+	+	....
11	8,000	Gas	+	+	+	+	—
		Acid col.	+	+	+	+	—
12	5,500	Gas	+	+	+	—	—
		Acid col.	+	+	+	....	....
13	9,400	Gas	+	+	+	+	+
		Acid col.	+	+	+	+	+
14	17,800	Gas	+	+	+	+	+
		Acid col.	+	+	+	+	+
15	8,900	Gas	....	+	+	+	....
		Acid col.	....	+	+	+	....
17	13,600	Gas	....	+	+	—	—
		Acid col.	....	+	+	....	....
18	18,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
19	9,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
20	29,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
21	20,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
22	30,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
24	9,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
25	4,500	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
26	5,300	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
27	7,400	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	—
28	5,200	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
29	5,900	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
July 1	7,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
2	24,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
3	10,600	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
4	37,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
5	104,000	Gas	....	+	+	—	—
		Acid col.	....	+	+	....	....
6	30,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	—	....
8	4,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
9	7,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
10	40,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
11	40,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
12	12,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
13	7,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
15	60,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
16	34,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
17	15,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
18	18,000	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
19	11,200	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....
20	4,500	Gas	....	+	+	—	—
		Acid col.	....	+	+	....	....
22	5,700	Gas	....	+	+	+	—
		Acid col.	....	+	+	+	....

TABLE X—Continued.

Date.	Sampling point 13, Kansas River, at Lawrence, from bridge.						
	Bacteria.	Gas, acid col.	10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 23	3,000	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....
24	....	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....
25	7,300	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
26	3,250	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
27	1,800	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....
29	13,000	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
30	1,400	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....
31	1,800	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....

TABLE XI.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans.]

Date.	Sampling point 14, Kansas River, Bonner Springs, Kans.						
	Bacteria.	Gas, acid col.	B. coli in—				
			10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
June 11	12,200	Gas	+	+	+	+	−
		Acid col.	+	+	+	+	....
12	7,000	Gas	+	+	+	+	−
		Acid col.	+	+	+	+	....
13	10,000	Gas	+	+	+	+	+
		Acid col.	+	+	+	+	+
14	6,000	Gas	+	+	+	+	−
		Acid col.	+	+	+	−	....
15	7,000	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
18	7,000	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....
19	12,300	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
20	31,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
21	25,000	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
22	29,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
24	40,000	Gas	....	+	+	....	....
		Acid col.	....	+	+	+	−
25	20,000	Gas	....	+	+	+	....
		Acid col.	....	+	+	+	+
26	7,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
27	7,500	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	−
28	9,600	Gas	....	+	+	+	....
		Acid col.	....	+	+	+	−
29	1,400	....	....	+	+	−	−
July 1	15,000	Gas	....	+	+	−	−
		Acid col.	....	+	+	....	....
2	52,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
3	35,000	Gas	....	+	+	+	−
		Acid col.	....	+	+	+	....
4	129,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+
5	Spreader	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	−
6	27,000	Gas	....	+	+	+	+
		Acid col.	....	+	+	+	+

TABLE XI—Continued.

Date.	Sampling point 14, Kansas River, Bonner Springs, Kans.						
	Bacteria.	Gas, acid col.	B. coli in—				
			10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 8	32,000	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
9	20,000	Gas	....	+	+	+	+
		Acid col	....	+	+	+	+
10	28,000	Gas	....	+	+	+	+
		Acid col	....	+	+	+	+
11	82,000	Gas	....	+	+	+	+
		Acid col	....	+	+	+	+
12	40,000	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
13	11,000	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
15	40,000	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
16	14,000	Gas	....	+	+	+	+
		Acid col	....	+	+	+	+
17	5,000	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
18	30,000	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
19	3,300	Gas	....	+	+	+	+
		Acid col	....	+	+	+	+
20	4,200	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
22	3,700	Gas	....	+	+	+	—
		Acid col	....	+	+	+	....
23 Received too late.							
24	1,800	Gas	....	+	—	—	—
		Acid col	....	+	....	....	....
25	3,400	Gas	....	+	+	—	—
		Acid col	....	+	+	....	....
26	28,300	Gas	....	+	+	—	—
		Acid col	....	+	+	....	....
27	2,500	Gas	....	+	+	—	—
		Acid col	....	+	+	....	....
29	10,000	Gas	....	+	—	—	—
		Acid col	....	+	....	....	....
30	1,100	Gas	....	+	—	—	—
		Acid col	....	+	....	....	....
31	1,000	Gas	....	+	+	—	—
		Acid col	....	+	+	....	....

TABLE XII.

[Hospital and Health Board, Kansas City, Mo., Pathological Laboratory; Dr. J. R. Vanatta.]

Date.	Sampling point 16, Missouri River, at Qumdaro, above the mouth of the Kansas.					Sampling point 15, Kansas River, at Kansas City, Kans.					
	Total count.	B. coli in—				Total count.	B. coli in—				
		0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.		0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.	0.00001 c. c.
May 29	57,000	......	+	—	......	*400,000	......	+	—	......	......
30	58,400	+	—	......	......	No growth.	......	......	+	—	......
31	29,100	......	+	—	......	*9,680,000	......	+	—	......	......
June 1	54,000	—	......	......	......	*13,048,000	......	......	+	—	......
2	*3,570,000	......	+	—	......	184,000	......	......	......	+	—
3	440,000	......	+	—	......	23,300	......	......	+	—	......
4	37,000	......	+	—	......	289,000	......	......	+	—	......
5	223,000	......	......	+	—	224,200	......	+	—	......	......
6	35,000	......	+	—	......	205,000	......	+	—	......	......
7	58,000	......	+	—	......	98,000	......	......	+	—	......
8	150,000	......	+	—	......	100,000	......	......	......	+	—
9	42,000	......	+	—	......	290,000	......	......	+	—	—
10	23,000	—	......	......	......	92,000	......	+	—	......	......
11	21,000	......	+	—	......	435,000	......	......	+	—	......
12	30,000	......	+	—	......	78,000	......	......	......	+	—
13	76,000	......	+	—	......	(1)	......	......	+	—	......
14	29,000	+	—	......	......	161,000	......	......	+	—	......
15	24,000	......	+	—	......	80,000	......	......	+	—	......
16	23,000	......	+	—	......	60,000	......	+	—	......	......
17	70,000	......	+	—	......	330,000	......	......	......	+	—
18	50,000	......	+	—	......	60,000	......	......	+	—	......
19	40,000	+	—	......	......	180,000	......	......	+	—	......
20	25,000	......	+	—	......	Spreader.	......	+	—	......	......
21	*4,500,000	......	+	—	......	20,000	......	+	—	......	......
22	32,000	......	+	—	......	60,000	......	+	—	......	......
23	41,000	......	+	—	......	67,000	......	......	+	—	......
24	Spreader.	+	—	......	......	100,000	......	+	—	......	......
25	10,000	+	—	......	......	49,000	......	......	......	+	—
26	3,600	—	......	......	......	4,000	—	......	......	......	......
27	10,000	+	—	......	......	26,000	......	+	—	......	......
28	13,000	......	......	+	—	26,000	......	+	—	......	......
29	16,000	......	+	—	......	13,000	+	—	......	......	......
30	15,000	......	+	—	......	20,000	+	—	......	......	......
July 1	4,400	......	+	—	......	10,000	......	......	+	—	......
2	6,000	+	—	......	......	22,000	......	+	—	......	......
3	8,000	—	......	......	......	56,000	......	+	—	......	......
4	Spreader.	......	+	—	......	29,000	......	......	+	—	......
5	6,400	......	......	+	—	30,000	......	—	......	......	......
6	19,000	......	......	+	—	25,000	......	+	—	......	......
7	41,900	......	+	—	......	40,000	......	+	—	......	......
8	105,000	......	+	—	......	42,000	......	—	......	......	......
9	10,000	—	......	......	......	28,000	......	......	......	+	......
10	17,000	......	+	—	......	9,000	......	......	+	—	......
11	5,000	+	—	......	......	29,000	......	+	—	......	......
12	6,400	......	+	—	......	6,000	......	—	......	......	......
13	12,000	......	+	—	......	7,400	......	+	—	......	......
14	28,000	......	+	—	......	122,000	......	......	......	+	—
15	10,000	......	+	—	......	Spreader.	......	+	—	......	......
16	8,000	......	......	......	*+	50,000	......	......	......	+	—
17	11,900	......	+	—	......	60,000	......	......	+	—	......
18	2,400	......	+	—	......	121,000	......	......	......	+	—
19	Spreader.	......	+	—	......	Spreader.	......	......	+	—	......
20	56,000	......	+	—	......	105,000	......	+	—	......	......
21	19,900	......	......	+	—	*1,320,000	......	......	+	—	......
22	6,000	......	+	—	......	287,000	......	+	—	......	......
23	8,000	+	—	......	......	102,000	......	......	+	—	......
24	45,000	......	+	—	......	154,000	......	......	+	—	......
25	7,000	......	+	—	......	11,400	......	......	......	+	—
26	19,000	......	+	—	......	77,000	......	......	+	—	......
27	19,100	......	......	+	—	46,000	......	+	—	......	......
28	135,000	......	+	—	......	94,000	......	......	+	—	......
29	45,000	......	......	+	—	115,000	......	......	+	—	......

[1] Overgrowth.

* Left out of averages.

TABLE XIII.

[Hospital and Health Board, Kansas City, Mo., Pathological Laboratory; Dr. J. R. Vanatta.]

Date.	Sampling point 17, Missouri River, below the Troost Avenue sewer.						Sampling point 18, Missouri River, at the waterworks, Independence, Mo.					
	Total count.	B. coli in—					Total count.	B. coli in—				
		0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.	0.00001 c. c.		0.1 c. c.	0.01 c. c.	0.001 c. c.	0.0001 c. c.	0.00001 c. c.
May 29	116,000	......	......	+	−	......	......	......	......	......	......	......
30	300,000	......	......	+	−	......	......	......	......	......	......	......
31	220,000	......	+	−	......	......	......	......	......	......	......	......
June 1	241,000	......	......	+	−	......	......	......	......	......	......	......
2	160,000	......	......	+	−	......	......	......	......	......	......	......
3	84,000	......	......	+	−	......	......	......	......	......	......	......
4	430,000	......	......	+	−	......	......	......	......	......	......	......
5	57,000	......	......	......	+	−	......	......	......	......	......	......
6	45,000	......	......	......	+	−	......	......	......	......	......	......
7	463,000	......	......	......	+	−	......	......	......	......	......	......
8	300,000	......	......	+	−	......	......	......	......	......	......	......
9	*1,128,000	......	+	−	......	......	......	......	......	......	......	......
10	60,000	......	......	+	−	......	54,000	......	+	−	......	......
11	520,000	......	......	+	−	......	*577,000	......	+	−	......	......
12	397,000	......	......	+	−	......	121,000	......	+	−	......	......
13	48,000	......	+	−	......	......	32,800	......	......	......	+	−
14	110,000	......	......	+	−	......	50,000	......	+	−	......	......
15	79,000	......	......	+	−	......	22,200	......	......	+	−	......
16	93,000	......	+	−	......	......	109,000	......	+	−	......	......
17	500,000	......	+	−	......	......	220,000	......	......	+	−	......
18	74,000	......	......	+	−	......	*940,000	......	......	+	−	......
19	190,000	......	+	−	......	......	80,000	......	+	−	......	......
20	58,000	......	......	+	−	......	60,000	......	......	+	−	......
21	40,000	......	......	+	−	......	130,000	......	......	+	−	......
22	50,000	......	......	+	−	......	120,000	......	+	−	......	......
23	760,000	......	......	+	−	......	34,000	......	......	+	−	......
24	Spreader.	......	+	−	......	......	140,000	+	−	......	......	......
25	210,000	......	......	+	−	......	20,000	......	+	−	......	......
26	9,000	−	......	......	......	......	20,000	......	+	−	......	......
27	25,000	......	+	−	......	......	10,000	......	+	−	......	......
28	27,000	......	+	−	......	......	44,000	......	+	−	......	......
29	30,000	......	+	−	......	......	36,000	......	+	−	......	......
30	20,000	......	......	+	−	......	17,000	+	−	......	......	......
July 1	18,000	......	......	......	+	−	12,000	......	......	......	+	−
2	31,000	......	......	+	−	......	32,000	......	+	−	......	......
3	40,000	......	......	+	−	......	19,000	......	+	−	......	......
4	Spreader.	......	+	−	......	......	20,000	......	+	−	......	......
5	11,000	......	+	−	......	......	34,000	......	−	......	......	......
6	39,000	......	......	+	−	......	26,000	......	+	−	......	......
7	65,000	......	......	......	......	......	19,000	......	......	......	......	......
8	200,000	......	......	......	+	−	62,000	......	−	......	......	......
9	25,000	......	+	−	......	......	30,000	......	+	−	......	......
10	24,000	......	+	−	......	......	20,000	......	+	−	......	......
11	15,000	......	+	−	......	......	16,000	......	+	−	......	......
12	33,000	......	......	+	−	......	8,600	......	+	−	......	......
13	16,000	......	+	−	......	......	5,200	−	......	......	......	......
14	34,000	......	......	+	−	......	23,000	......	+	−	......	......
15	22,000	......	+	−	......	......	8,200	+	−	......	......	......
16	13,800	......	−	......	......	......	240,000	......	......	......	+	......
17	31,000	......	......	+	−	......	8,000	......	+	−	......	......
18	11,000	......	+	−	......	......	10,900	......	+	−	......	......
19	Spreader.	......	......	......	+	−	Spreader.	......	......	......	+	−
20	Spreader.	......	......	+	−	......	47,200	......	......	+	−	......
21	97,000	......	+	−	......	......	180,000	......	+	−	......	......
22	200,000	......	......	......	+	−	53,000	......	+	−	......	......
23	87,000	......	......	......	+	−	11,000	......	+	−	......	......
24	25,700	......	......	+	−	......	17,600	......	+	−	......	......
25	26,000	......	......	+	−	......	40,000	......	+	−	......	......
26	60,000	......	+	−	......	......	33,000	......	......	+	−	......
27	45,000	......	......	+	−	......	54,000	......	......	+	−	......
28	30,000	......	......	+	−	......	......	......	......	......	......	......
29	69,000	......	......	......	+	−	105,000	......	+	−	......	......
30	......	......	......	......	......	......	9,000	......	+	−	......	......
31	......	......	......	......	......	......	19,000	......	......	+	−	......
Aug. 1	......	......	......	......	......	......	24,000	......	+	−	......	......

* Left out of averages.

Table XIV.

[Missouri State Board of Health, Bacteriological Laboratory; Murray C. Stone, M. D., bacteriologist, Jefferson City.]

Date.	Sampling point 19, Missouri River, at Jefferson City, Mo., at bridge.			
	Total bacterial count.	B. coli in—		
		0.1 c. c.	0.01 c. c.	0.001 c. c.
June 1	16,000	+	−	−
3	25,000	+	+	−
5	42,000	+	+	−
6	46,000	+	−	−
7	30,000	+	+	−
8	30,000	+	+	−
9	20,000	+	−	+
10	28,000	+	+	−
11	18,500	+	+	−
12	18,500	+	−	−
13	10,500	+	+	−
14	100,000	+	+	−
15	60,000	+	+	−
17	55,000	+	+	−
18	35,000	+	−	−
19	40,000	+	+	−
20	20,000	+	+	−
21	25,000	+	−	−
22	12,000	+	+	+
24	10,000	+	+	−
25	8,500	+	−	−
26	7,500	+	+	−
27	6,500	+	+	−
28	10,000	+	+	−
29	14,000	+	+	+

Date.	Total bacterial count.	B. coli in—				
		10 c. c.	1 c. c.	0.1 c. c.	0.01 c. c.	0.001 c. c.
July 1	20,000	....	+	+	+	−
2	90,000	....	+	+	+	−
3	14,000	....	+	+	+	+
5	30,000	....	+	+	+	−
6	11,000	....	+	+	+	−
8	4,500	....	....	+	+	−
9	14,000	....	+	+	+	+
10	13,000	....	....	+	+	−
11	9,000	....	+	+	−	....
12	8,400	....	+	+	+	−
13	13,000	....	+	+	−	−
15	11,000	....	+	+	−	−
16	9,500	....	....	+	+	−
17	10,500	....	....	+	+	−
18	12,000	....	....	+	+	+
19	9,500	....	....	+	+	−
20	9,000	....	....	+	+	−
22	18,000	....	....	+	+	+
23	35,000	....	....	+	+	−
24	12,000	....	....	+	−	−
25	14,000	....	....	+	+	−
26	30,000	....	....	+	+	+
27	26,000	....	....	+	+	−
29	30,000	....	....	+	+	+
30	28,000	....	....	+	+	−
31	23,500	....	....	+	+	−

TABLE XV.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans.; Mr. Young.]

MISSOURI RIVER AT ATCHISON.

No.	Source.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_3.	Conductivity.
1	A. C.	4,950	7,4	3.18	0.001	0.50	10.0	166.5	12.42
2	B. C.	5,377	7.2	5.25	.02	.50	11.0	168.5	12.52
3	C. S.	4	7.9	2.15	.000	.50	12.0	163.0	13.32
4	A. C.	4,932	6.9	2.63	.001	.50	10.0	170.0	12.88
5	B. C.	4,932	6.0	3.42	.01	.50	11.0	163.0	12.88
6	C. S.	7	7.1	2.75	.000	.50	13.0	166.5	13.78
7	A. C.	5,842	7.0	3.71	.001	.50	10.0	158.0	12.60
8	B. C.	5,985	7.3	3.56	.01	.50	13.0	160.0	12.63
9	C. S.	90	6.7	2.20	.000	.50	14.0	153.0	13.50
10	A. C.	4,450	7.78	2.90	.001	.70	10.0	170.0	6.50
11	B. C.	5,674	8.48	3.50	.02	.70	10.0	167.5	6.55
12	C. S.	37	8.54	2.60	.000	1.00	10.0	156.5	7.30
13	A. C.	5,162	8.19	2.07	.001	.50	9.0	151.7	6.16
14	B. C.	5,168	7.68	2.85	.01	.50	8.0	147.0	6.13
15	C. S.	123	8.52	2.42	.001	.70	12.0	144.5	7.14
16	A. C.	4,594	7.84	2.45	.000	.50	9.0	158.0	6.08
17	B. C.	4,949	8.10	3.38	.000	.50	10.0	156.5	5.88
18	C. S.	61	8.38	3.18	.000	.70	12.0	148.0	7.14
19	A. C.	5,704	7.55	2.43	.002	.50	12.0	139.5	5.63
20	B. C.	6,135	6.11	3.27	.001	.50	10.0	154.0	5.56
21	C. S.	105	7.77	2.75	.003	1.00	10.0	147.0	7.06
22	A. C.	5,315	4.29	2.54	.000	.30	7.0	154.0	5.8
23	B. C.	4,956	7.11	3.86	.000	.30	8.0	161.5	4.8
24	C. S.	129	7.83	2.94	.000	.50	9.0	150.7	6.5
25	A. C.	6,620	6.72	3.07	.000	.30	9.0	149.5	4.6
26	B. C.	4,776	7.72	2.90	.000	.30	8.0	152.0	4.5
27	C. S.	31	7.81	2.63	.000	.50	9.0	154.0	6.2
28	A. C.	4,754	7.01	2.35	.000	.30	8.0	145.6	4.3
29	B. C.	4,732	7.13	2.50	.000	.30	11.0	145.6	4.3
30	C. S.	74	8.45	2.28	.000	.50	10.0	150.7	6.1
31	A. C.	4,438	7.17	3.10	.000	.30	6.0	128.7	4.2
32	B. C.	4,246	7.20	3.84	.000	.30	6.0	159.0	4.2
33	C. S.	17	7.29	2.90	.000	.50	7.0	155.5	5.9
34	A. C.	3,952	6.62	1.88	.000	.30	9.0	164.0	4.2
35	B. C.	4,038	7.07	3.24	.000	.50	9.0	154.0	4.3
36	C. S.	211	7.42	2.50	.000	.50	8.0	143.5	5.6
37	A. C.	4,076	6.37	2.07	.000	.30	9.0	142.0	4.6
38	Broken.	....	....	....	....	....	....	....	....
39	C. S.	173	7.13	2.06	.000	.30	8.0	145.6	5.4
40	A. C.	3,378	6.65	2.08	.000	.3	8.4	142.0	4.55
41	B. C.	3,390	6.05	2.42	.000	.3	10.0	149.5	4.50
42	C. S.	106	7.20	2.47	.000	.3	9.0	149.5	5.30
43	A. C.	3,048	6.62	2.46	.000	.3	9.0	150.5	4.55
44	B. C.	3,144	6.81	2.27	.000	.3	8.0	153.0	5.55
45	C. S.	125	6.66	2.01	.000	.3	8.4	142.0	5.30
46	A. C.	3,492	6.94	2.08	.000	.3	9.0	148.2	5.75
47	B. C.	3,646	6.94	2.37	.000	.3	8.0	141.0	4.70
48	C. S.	94	7.00	1.81	.000	.3	8.0	147.0	5.20
49	A. C.	3,280	6.98	2.41	.000	.3	7.0	141.0	....
50	B. C.	3,400	6.94	1.59	.000	.3	11.0	178.5	....
51	C. S.	113	6.81	2.43	.000	.3	7.0	139.5	....
52	A. C.	3,754	5.86	2.58	.000	.3	11.0	132.5	....
53	B. C.	3,938	7.17	3.24	.000	.3	11.0	135.0	....
54	C. S.	110	5.82	3.01	.000	.3	10.0	145.6	....
55	A. C.	2,952	6.21	2.20	.000	.30	8.0	130.0	4.39
56	B. C.	3,400	6.69	2.88	.000	.30	9.0	132.5	4.44
57	C. S.	110	6.88	2.55	.000	.30	12.0	132.5	4.89
58	A. C.	2,676	6.53	2.70	.000	.30	8.0	133.5	4.50
59	B. C.	3,404	6.56	3.00	.000	.30	8.0	140.7	4.45
60	C. S.	111	7.23	2.80	.000	.30	9.0	135.0	4.95
61	A. C.	3,790	6.78	2.75	.000	.30	14.0	131.2	4.38
62	B. C.	3,448	6.69	2.93	.000	.30	9.0	137.4	4.33
63	C. S.	112	7.01	2.52	.000	.30	10.0	131.2	5.08
64	A. C.	3,550	6.67	2.69	.000	.30	9.0	140.7	4.37
65	B. C.	3,490	5.70	3.07	.000	.30	11.0	135.0	4.40
66	C. S.	153	7.14	3.01	.000	.30	8.4	128.7	5.12
67	A. C.	6,280	5.86	3.02	.000	.30	7.0	143.5	4.20
68	B. C.	5,538	6.78	2.72	.000	.30	9.0	138.5	4.15
69	C. S.	78	7.13	2.46	.000	.30	9.0	128.7	5.00
70	A. C.	6,928	6.62	2.59	.000	.30	9.4	130.0	4.48
71	B. C.	7,236	6.52	2.37	.000	.30	8.0	105.7	4.42
72	C. S.	90	7.20	2.84	.000	.30	10.0	126.5	5.07
73	A. C.	6,200	6.75	2.50	.000	.30	9.0	139.5	4.33
74	B. C.	6.480	8.00	2.86	.000	.30	12.0	131.0	4.33

Table XV—Continued.

MISSOURI RIVER AT ATCHISON—Continued.

No.	Source.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_3.	Conductivity.
75	C. S.	106	7.23	2.67	0.000	0.30	8.0	127.5	4.933
76	A. C.	5,718	7.65	2.38	.000	.30	10.0	131.0	4.500
77	B. C.	5,918	6.81	1.92	.000	.30	12.0	131.0	4.455
78	C. S.	110	7.71	2.45	.000	.30	9.0	134.6	5.100
79	A. C.	5,852	6.88	1.2	.000	.30	11.0	127.5	4.522
80	B. C.	6,014	7.30	2.5	.000	.30	16.0	129.8	4.577
81	C. S.	74	5.76	2.8	.000	.30	11.0	128.7	5.100
82	A. C.	6,422	6.24	3.10	.000	.30	8.0	133.5	4.522
83	B. C.	6,674	7.13	3.05	.000	.30	9.0	138.5	4.577
84	C. S.	132	6.50	2.25	.000	.30	8.0	141.0	4.877
85	A. C.	6,624	7.04	2.6	.000	.30	12.0	137.2	4.955
86	B. C.	6,978	6.43	3.0	.000	.30	10.0	137.2	4.900
87	C. S.	46	6.69	2.2	.000	.30	9.0	133.5	5.100
88	A. C.	7,744	6.91	2.9	.000	.30	7.0	144.5	5.155
89	B. C.	8,022	7.04	3.0	.000	.30	6.0	142.0	5.155
90	C. S.	129	7.17	3.5	.000	.30	8.0	137.2	4.955
91	A. C.	7,490	6.78	2.9	.000	.30	8.0	143.4	5.000
92	B. C.								
93	C. S.	130	7.04	2.6	.000	.30	8.0	136.0	5.288
94	A. C.	5,296	6.30	2.5	.000	.30	5.0	138.5	4.900
95	B. C.	5,508	7.10	2.5	.000	.30	6.0	142.0	4.855
96	C. S.	116	6.30	3.7	.000	.30	8.0	136.0	5.555
97	A. C.	5,278	6.30	3.0	.000	.30	8.0	139.6	5.033
98	B. C.	5,586	6.72	2.6	.000	.30	8.0	136.0	5.188
99	C. S.	93	6.55	2.7	.000	.30	8.0	141.0	5.533
100	A. C.	4,936	4.48	2.9	.000	.30	8.0	141.0	
101	B. C.	5,400	4.99	3.1	.000	.30	9.0	143.4	
102	C. S.	102	5.41	2.3	.000	.30	9.0	133.5	
103	A. C.	5,088	6.49	2.4	.000	.30	9.0	138.5	
104	B. C.	5,176	7.11	2.6	.000	.30	12.0	133.5	
105	C. S.	106	6.88	2.7	.000	.30	8.0	128.6	
106	A. C.	4,320	7.77	2.4	.000	.30	8.0	146.9	
107	B. C.	4,770	6.79	2.5	.000	.30	10.0	143.4	
108	C. S.	80	6.56	2.5	.000	.30	10.0	137.0	
109	A. C.	3,254	7.01	1.9	.000	.30	9.0	141.0	
110	B. C.	3,584	7.03	1.4	.000	.30	10.0	143.4	
111	C. S.	81	6.85	1.1	.000	.30	11.0	123.9	
112	A. C.	3,110	7.17	2.4	.000	.30	10.0	133.5	
113	B. C.	3,180	6.56	2.5	.000	.30	9.0	137.0	
114	C. S.	75	6.88	2.4	.000	.30	10.0	113.0	

TABLE XVI.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans.; Mr. Young.]

MISSOURI RIVER, AT LEAVENWORTH.

No.	Source.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_3.	Conductivity.
1	A. C.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
2	B. C.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
3	C. S.	10	8.0	1.46	0.001	0.30	13.0	143.0	12.87
4	A. C.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
5	B. C.	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)
6	C. S.	14	8.0	1.45	.02	.30	14.0	143.0	12.86
7	A. C.	3,644	6.9	2.28	.005	.50	12.0	171.5	12.60
8	B. C.	3,545	4.5	2.91	.04	.50	20.0	147.0	14.93
9	C. S.	12	8.3	1.19	.000	.35	11.6	144.5	12.87
10	A. C.	4,916	6.8	2.74	.005	.50	12.0	166.5	12.30
11	B. C.	4,948	6.5	2.58	.04	.50	12.0	159.0	12.33
12	C. S.	72	7.4	1.68	.000	.70	12.0	136.0	12.83
13	A. C.	5,528	6.6	2.57	.005	.50	12.0	160.5	12.89
14	B. C.	5,213	8.9	2.67	.03	.50	11.0	160.5	12.89
15	C. S.	2	4.2	1.81	.000	.70	15.0	132.5	13.07
16	A. C.	5,730	8.35	2.67	.000	.50	15.0	164.0	7.06
17	B. C.	5,425	7.91	2.83	.000	.50	17.0	164.0	6.96
18	C. S.	10	8.35	0.97	.04	.50	9.0	136.0	7.06
19	A. C.	5,788	7.38	2.87	.000	.50	10.0	172.5	6.63
20	B. C.	2,384	8.22	2.76	.02	.50	10.0	148.0	6.50
21	C. S.	13	8.58	1.52	.04	.50	12.0	128.8	6.90
22	A. C.	5,525	7.26	2.33	.000	.50	13.0	155.5	6.09
23	B. C.	5,116	7.65	2.44	.01	.50	10.0	154.0	6.21
24	C. S.	17	8.42	1.16	.000	.70	12.0	123.8	6.99
25	A. C.	3,937	7.48	3.30	.000	.50	9.0	158.0	6.10
26	B. C.	4,600	7.87	3.10	.000	.50	11.0	153.0	6.03
27	C. S.	14	5.15	1.30	.000	.50	11.0	128.8	6.83
28	A. C.	4,610	7.36	1.68	.000	.50	10.0	156.5	5.79
29	B. C.	4,789	7.07	2.05	.000	.50	11.0	147.0	5.98
30	C. S.	640	7.36	0.62	.000	.50	10.0	130.0	6.68
31	A. C.	5,713	7.46	2.02	.002	.50	9.0	150.0	5.63
32	B. C.	5,343	8.19	2.01	.002	.50	9.0	144.5	5.68
33	C. S.	24	8.23	2.43	.000	.50	10.0	122.5	6.47
34	A. C.	5,712	6.91	2.43	.000	.50	10.0	166.3	4.9
35	B. C.	5,070	8.07	2.47	.000	.30	9.0	150.7	4.9
36	C. S.	27	8.22	1.56	.000	.50	9.0	127.5	5.8
37	A. C.	1,541	7.10	2.94	.000	.30	8.0	148.0	4.6
38	B. C.	4,288	7.36	3.09	.000	.50	8.0	154.0	4.6
39	C. S.	20	7.29	1.54	.000	.50	8.0	119.0	5.5
40	A. C.	4,610	6.65	2.35	.000	.50	10.0	146.5	4.4
41	B. C.	4,502	7.84	2.01	.000	.50	10.0	144.5	4.4
42	C. S.	23	7.75	1.19	.000	.50	10.0	120.0	5.2
43	A. C.	4,798	3.07	3.40	.000	.30	6.0	132.0	4.2
44	B. C.	4,340	7.29	1.68	.000	.30	7.0	147.0	4.2
45	C. S.	24	7.45	1.38	.000	.30	7.0	145.6	4.9
46	A. C.	4,498	6.27	1.89	.000	.30	7.0	144.5	4.3
47	B. C.	4,132	6.4	1.74	.000	.30	9.0	154.0	4.2
48	C. S.	112	6.91	1.00	.000	.30	9.0	125.0	4.6
49	A. C.	3,988	6.85	1.62	.000	.30	9.0	142.0	4.6
50	B. C.	3,642	5.69	2.23	.000	.30	10.0	139.6	4.6
51	C. S.	32	7.61	0.68	.000	.50	10.0	118.0	4.8
52	A. C.	3,308	6.33	2.35	.000	.30	10.0	143.0	4.70
53	B. C.[1]	...	...	...	...	...	...	...	...
54	C. S.	11	7.55	1.33	.000	.50	10.6	110.5	4.95
55	A. C.	3,259	6.56	1.32	.000	.30	9.0	142.5	4.50
56	B. C.	2,796	6.24	1.64	.000	.30	9.0	147.0	5.55
57	C. S.	10	6.77	0.55	.000	.50	10.0	109.2	4.90
58	A. C.	3,586	6.33	1.84	.000	.30	9.0	142.0	4.60
59	B. C.	3,160	6.11	2.26	.000	.30	9.0	139.5	5.60
60	C. S.	10	6.94	1.04	.000	.50	8.0	116.5	4.80
61	A. C.	2,376	6.78	1.53	.000	.30	8.0	136.0	...
62	B. C.	2,750	6.88	2.07	.000	.50	12.0	136.0	...
63	C. S.	15	7.64	0.97	.000	.70	10.0	114.0	...
64	A. C.	3,652	6.02	2.33	.000	.30	11.0	143.0	...
65	B. C.	4,060	6.91	2.60	.000	.50	11.0	139.5	...
66	C. S.	12	7.46	1.27	.000	.50	12.0	117.7	...
67	A. C.	3,506	6.62	1.83	.000	.50	8.0	133.5	4.50
68	B. C.	3,752	5.76	2.10	.000	.50	9.4	136.0	4.70
69	C. S.	14	6.91	0.80	.000	.50	11.0	109.4	4.92
70	A. C.	3,467	6.24	2.14	.000	.50	7.0	135.0	4.50
71	B. C.	4,176	6.91	2.30	.000	.50	9.0	132.5	4.55
72	C. S.	14	7.01	1.10	.000	.50	10.0	102.0	4.90
73	A. C.	3,550	6.05	2.44	.000	.30	9.0	143.5	4.57
74	B. C.	3,516	7.62	2.42	.000	.30	14.0	133.5	4.48

[1] No sample.

TABLE XVI—Continued.

MISSOURI RIVER, AT LEAVENWORTH—Continued.

No.	Source.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_2.	Conductivity.
75	C. S	10	7.55	1.26	0.000	0.30	11.0	110.5	4.98
76	A. C	3,564	6.43	2.35	.000	.30	9.4	125.0	5.45
77	B. C	3,416	5.79	2.55	.000	.30	7.8	138.5	4.40
78	C. S	20	7.17	1.50	.000	.30	9.6	113.0	5.02
79	A. C	5,324	6.69	2.31	.000	.30	9.0	137.4	4.20
80	B. C	4,994	6.62	2.35	.000	.30	10.0	132.5	4.20
81	C. S	15	6.69	1.46	.000	.30	10.0	113.0	4.80
82	A. C	6,950	6.21	1.85	.000	.30	10.0	132.5	4.42
83	B. C	7,400	6.48	2.18	.000	.30	12.0	135.0	4.42
84	C. S	12	7.81	0.96	.000	.50	9.6	110.5	4.87
85	A. C	6,236	6.75	2.01	.000	.30	8.0	132.3	4.35
86	B. C	5,142	6.98	1.93	.000	.30	7.0	142.0	4.43
87	C. S	20	7.48	.62	.000	.30	11.0	115.5	4.73
88	A. C	6,328	7.52	1.90	.000	.30	8.0	133.5	4.40
89	B. C	5,974	7.33	2.22	.000	.30	9.0	141.0	4.35
90	C. S	15	7.78	0.88	.000	.30	8.0	110.5	4.70
91	A. C	5,890	6.94	1.3	.000	.30	12.0	134.6	4.57
92	B. C	5,430	6.98	1.4	.000	.30	13.0	133.5	4.52
93	C. S	30	7.65	0.5	.000	.30	10.0	104.5	4.62
94	A. C	6,230	6.53	2.45	.000	.30	9.0	141.0	4.80
95	B. C	6,120	6.50	2.90	.000	.30	8.4	145.7	4.80
96	C. S	20	7.46	1.60	.000	.30	10.6	110.0	4.85
97	A. C	5,470	7.01	2.5	.000	.30	9.0	139.5	5.05
98	B. C	5,974	6.69	2.8	.000	.30	10.0	133.5	5.05
99	C. S	20	6.82	1.3	.000	.30	10.0	132.3	5.06
100	A. C	7,032	6.72	2.7	.000	.30	7.0	149.2	----------
101	B. C	8,120	6.82	3.2	.000	.30	8.0	141.0	----------
102	C. S	30	6.85	2.0	.000	.30	10.0	111.6	----------
103	A. C	7,348	6.47	2.5	.000	.30	7.0	150.5	5.10
104	B. C	7,428	6.56	2.5	.000	.30	6.0	145.7	5.05
105	C. S	30	6.97	1.2	.000	.30	8.0	109.3	5.60
106	A. C	5,256	6.18	2.2	.000	.30	5.0	143.4	4.90
107	B. C	5,542	6.27	2.3	.000	.30	7.0	139.6	4.90
108	C. S	25	7.74	1.6	.000	.30	8.0	111.6	5.70
109	A. C	4,944	5.03	2.8	.000	.30	8.0	150.5	4.98
110	B. C	5,288	6.62	3.1	.000	.30	8.0	137.0	4.98
111	C. S	5,228	6.65	1.6	.000	.30	7.0	96.0	5.63
112	A. C	6,660	6.37	2.8	.000	.30	7.0	133.5	----------
113	B. C	5,652	7.68	3.1	.000	.30	8.0	128.6	----------
114	C. S	25	5.89	4.2	.000	.30	8.0	97.3	----------
115	A. C	4,920	6.72	3.0	.000	.30	9.0	136.0	----------
116	B. C	5,920	7.11	1.3	.000	.30	10.0	148.0	----------
117	C. S	20	7.36	0.9	.000	.30	10.0	92.5	----------
118	A. C	4,536	6.75	2.5	.000	.30	10.0	140.7	----------
119	B. C	3,440	6.46	2.3	.000	.30	8.0	148.0	----------
120	C. S	20	7.55	1.1	.000	.30	11.0	99.7	----------
121	A. C	3,640	7.36	1.3	.000	.30	11.0	132.5	----------
122	B. C	3,560	7.43	2.4	.000	.30	11.0	150.5	----------
123	C. S	25	7.08	0.7	.000	.30	10.0	107.0	----------
124	A. C	4,126	6.69	1.4	.000	.30	10.0	137.0	----------
125	B. C	3,400	7.84	1.7	.000	.30	10.0	134.0	----------
126	C. S	15	7.04	0.5	.000	.30	9.0	109.3	----------
127	A. C	3,562	6.91	2.2	.000	.30	10.0	130.0	----------
128	B. C	3,068	7.04	2.5	.000	.30	13.0	132.0	----------
129	C. S	20	7.01	1.0	.000	.30	11.0	99.7	----------

TABLE XVII.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans., Mr. Young.]

KANSAS RIVER AT LAWRENCE (BRIDGE).

No.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_3.	Conductivity.
1	419	7.8	4.72	0.02	0.30	55.0	255.0	13.19
2	337	6.9	7.90	.01	.30	62.0	231.0	13.43
3	199	6.1	6.35	.03	.30	65.0	267.0	13.61
4	233	7.5	2.46	.005	.25	69.4	274.0	14.00
5	215	6.7	3.54	.01	.10	69.0	263.5	13.40
6	952	4.6	2.94	.01	.10	72.0	252.0	14.48
7	590	7.46	3.23	.000	.30	72.0	263.5	8.36
8	604	8.22	3.83	.000	.70	61.0	223.5	7.30
9	706	7.55	4.41	.000	1.00	70.0	214.0	7.16
10	653	6.97	3.40	.000	.70	70.0	208.0	7.19
11	564	7.87	2.24	.001	.70	80.0	175.0	7.73
12	740	6.37	3.26	.002	.70	42.0	170.0	5.53
13	405	7.14	2.87	.000	.70	35.0	207.5	5.3
14	273	6.69	4.04	.000	.70	47.0	256.0	6.1
15	140	6.59	3.02	.000	.50	71.0	207.5	7.2
16	372	6.21	2.84	.000	.50	73.0	211.0	7.6
17	267	6.50	2.30	.000	.50	73.0	228.0	7.7
18	275	5.44	2.45	.001	.50	72.6	209.0	7.6
19	207	6.88	2.84	.001	.50	59.0	254.0	8.05
20	283	6.66	2.10	.002	.50	46.0	229.5	7.1
21	230	5.60	2.47	.002	.50	41.0	225.0	6.9
22	336	6.85	3.47	.001	.50	40.0	237.0	6.8
23	300	6.43	2.80	.001	.30	44.0	243.0	....
24	326	6.46	2.67	.001	.30	36.0	179.7	....
25	386	6.59	2.20	.002	.30	55.0	203.0	6.90
26	410	6.18	3.07	.002	.50	56.0	191.0	6.75
27	974	6.87	3.36	.002	.50	57.0	198.0	5.92
28	1,022	6.08	3.49	.002	.50	62.0	184.7	7.25
29	446	6.62	3.78	.002	.50	64.0	197.0	6.65
30	470	6.88	2.50	.002	.30	90.0	198.0	8.02
31	1,110	6.49	5.47	.003	.50	43.0	187.0	5.76
32	548	5.98	3.51	.003	.50	49.0	210.0	6.45
33	282	7.01	1.4	.003	.50	33.0	203.0	5.32
34	302	6.72	0.60	.003	.50	40.0	207.5	5.95
35	252	6.91	3.5	.003	.50	35.0	231.0	6.05
36	190	5.82	2.8	.003	.50	48.0	248.0	....
37	122	6.05	2.5	.003	.50	52.0	274.5	7.25
38	83	6.40	2.6	.003	.50	47.0	273.0	7.05
39	88	5.37	2.9	.003	.50	49.0	271.0	7.18
40	70	5.79	3.0	.003	.50	59.0	266.0	....
41	76	7.21	2.0	.003	.50	62.0	273.0	....
42	65	6.72	2.7	.003	.50	65.0	290.0	....
43	62	6.14	0.9	.003	.50	70.0	280.0	....
44	60	5.69	1.6	.003	.50	76.0	283.0	....
45	77	6.33	2.2	.003	.50	80.0	287.0	....

TABLE XVIII.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans.; Mr. Young.]

KANSAS RIVER AT BONNER SPRINGS.

No.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_3.	Conductivity.
1	1,234	10.3	3.98	0.04	0.30	55.0	252.0	13.72
2	459	8.3	7.96	.04	.30	51.0	238.0	14.15
3	417	6.4	9.55	.03	.75	54.0	226.0	15.01
4	335	8.0	2.94	.005	.35	61.0	241.5	13.55
5	1,330	6.9	3.33	.005	.30	69.0	266.0	13.65
6	1,538	6.6	2.90	.005	.30	62.0	247.5	13.73
8	578	8.10	3.45	.000	.50	71.0	265.0	7.85
9	1,290	7.81	4.01	.001	.70	62.0	220.0	7.30
10	1,688	6.69	4.00	.000	.70	64.0	192.0	7.06
11	1,769	8.42	2.05	.001	1.00	79.0	197.0	7.60
12	1,500	7.81	3.50	.004	1.00	64.0	175.0	7.03
13	1,166	7.45	3.23	.004	.70	30.0	193.0	4.9
14	967	6.98	3.52	.002	.70	34.0	202.5	5.2
15	676	5.98	3.80	.001	.70	54.0	209.0	6.0
16	454	6.43	3.28	.001	.70	66.0	216.0	6.0
17	528	6.15	2.22	.002	.50	73.0	222.0	7.8
18	502	7.36	2.65	.001	.50	70.4	226.0	7.6
19	410	7.10	2.31	.001	.50	80.0	228.5	8.30
20	377	7.10	1.89	.001	.50	58.0	227.0	8.00
21	827	5.76	3.85	.001	.50	29.0	181.0	5.00
22	610	6.14	4.32	.001	.70	34.0	193.0	6.10
23	....	7.08	3.30	.01	.50	43.0	238.0	....
24	974	6.94	2.62	.002	.50	42.0	232.0	....
25	1,170	6.59	2.82	.002	.50	40.0	184.7	5.46
26	936	6.30	3.06	.002	.50	59.0	212.5	6.20
27	1,000	6.82	3.12	.001	.50	59.0	206.5	7.07
28	454	5.92	3.91	.001	.50	46.2	175.0	5.65
29	2,336	5.95	3.36	.001	.50	56.0	186.0	6.60
30	1,414	6.78	2.57	.001	.50	63.0	187.0	6.57
31	1,080	7.45	3.57	.002	.30	62.0	223.0	7.10
32	1,374	6.85	3.84	.002	.30	44.0	191.0	5.40
33	734	6.62	1.7	.002	.30	49.0	224.5	6.42
34	662	6.46	4.5	.002	.30	37.0	215.0	5.65
35	404	7.04	3.7	.002	.30	41.0	216.0	6.00
36	201	6.65	3.5	.002	.30	40.0	227.0	....
37	96	6.72	2.8	.002	.30	51.0	262.0	8.30
38	146	....	....	.002	.30	....	....	....
39	120	4.51	4.0	.002	.30	49.0	269.5	7.23
40	170	6.04	3.2	.002	.30	48.0	262.0	....
41	79	6.43	2.2	.002	.30	57.0	267.0	....
42	50	6.95	2.4	.002	.30	60.0	275.5	....
43	61	6.76	1.2	.002	.30	71.0	282.0	....
44	55	6.66	1.7	.002	.30	68.0	265.0	....
45	30	6.33	2.7	.002	.30	78.0	277.0	....

Table XIX.

[Kansas State Board of Health, Water and Sewage Laboratory, University of Kansas, Lawrence, Kans.; Mr. Young.]

KANSAS RIVER AT KANSAS CITY.

No.	Suspended matter.	Oxygen dissolved.	Oxygen consumed.	NO_2.	NO_3.	Cl.	HCO_3.	Conductivity.
1	116	....	4.90	0.004	1.0	39.0	187.0	5.2
2	167	....	3.82	.004	1.0	32.0	194.0	4.9
3	107	....	5.59	.003	.7	36.0	188.0	5.7
4	107	....	....	.003	1.0	69.0	205.0	7.2
5	153	....	....	.004	1.0	78.0	237.0	7.8
6	121	7.10	2.92	.003	1.0	76.6	225.0	8.00
7	110	6.66	3.42	.003	1.0	81.0	232.0	8.50
8	184	4.99	4.57	.003	.5	56.0	197.0	6.60
9	406	5.92	4.50	.003	.5	30.0	158.0	....
10	129	6.78	4.27	.003	.5	40.0	216.0	....
11	Broken.	....	....	.003	.5	....	....	....
19	140	6.52	5.00	.003	.50	61.0	210.0	7.05
20	176	7.62	5.8	.003	.50	49.0	187.0	6.02
22	188	6.56	4.94	.003	.50	53.0	222.0	6.80
24	206	5.38	5.4	.003	.50	42.0	219.8	6.10
26	182	4.83	7.5	.003	.50	43.0	231.0	....
28	94	4.80	5.0	.000	1.0	48.0	252.0	6.60
30	117	4.54	3.8	.000	1.0	54.0	284.0	7.44
32	71	4.16	4.2	.000	1.0	63.0	284.0	7.83
36	117	5.73	5.5	.000	1.0	70.0	272.0	....
38	126	5.66	5.0	.000	1.0	73.0	....	....
40	120	5.98	5.0	.000	1.0	68.0	264.0	....
42	110	5.28	4.3	.000	1.0	75.0	261.0	....
44	104	6.56	4.4	.000	1.0	73.0	276.8	....

HYGIENIC LABORATORY BULLETINS OF THE PUBLIC HEALTH AND MARINE-HOSPITAL SERVICE.

The Hygienic Laboratory was established in New York, at the Marine Hospital on Staten Island, August, 1887. It was transferred to Washington, with quarters in the Butler Building, June 11, 1891, and a new laboratory building, located in Washington, was authorized by act of Congress March 3, 1901.

The following *bulletins* [Bulls. Nos. 1-7, 1900 to 1902, Hyg. Lab., U. S. Mar.-Hosp. Serv., Wash.] have been issued:

*No. 1.—Preliminary note on the viability of the *Bacillus pestis*. By M. J. Rosenau.

No. 2.—Formalin disinfection of baggage without apparatus. By M. J. Rosenau.

*No. 3.—Sulphur dioxid as a germicidal agent. By H. D. Geddings.

*No. 4.—Viability of the *Bacillus pestis*. By M. J. Rosenau.

No. 5.—An investigation of a pathogenic microbe (*B. typhi murium* Danyz) applied to the destruction of rats. By M. J. Rosenau.

*No. 6.—Disinfection against mosquitoes with formaldehyde and sulphur dioxid. By M. J. Rosenau.

†No. 7.—Laboratory technique: Ring test for indol, by S. B. Grubbs and Edward Francis; Collodium sacs, by S. B. Grubbs and Edward Francis; Microphotography with simple apparatus, by H. B. Parker.

By act of Congress approved July 1, 1902, the name of the "United States Marine-Hospital Service" was changed to the "Public Health and Marine-Hospital Service of the United States," and three new divisions were added to the Hygienic Laboratory.

Since the change of name of the service the bulletins of the Hygienic Laboratory have been continued in the same numerical order, as follows:

*No. 8.—Laboratory course in pathology and bacteriology. By M. J. Rosenau. (Revised edition, March, 1904.)

†No. 9.—Presence of tetanus in commercial gelatin. By John F. Anderson.

*No. 10. Report upon the prevalence and geographic distribution of hookworm disease (uncinariasis or anchylostomiasis) in the United States. By Ch. Wardell Stiles.

*No. 11.—An experimental investigation of *Trypanosoma lewisi*. By Edward Francis.

*No. 12.—The bacteriological impurities of vaccine virus; an experimental study. By M. J. Rosenau.

*No. 13.—A statistical study of the intestinal parasites of 500 white male patients at the United States Government Hospital for the Insane; by Philip E. Garrison, Brayton H. Ransom, and Earle C. Stevenson. A parasitic roundworm (*Agamomermis culicis* n. g., n. sp.) in American mosquitoes (*Culex sollicitans*); by Ch. Wardell Stiles. The type species of the cestode genus *Hymenolepis;* by Ch. Wardell Stiles.

*No. 14.—Spotted fever (tick fever) of the Rocky Mountains; a new disease. By John F. Anderson.

*No. 15.—Inefficiency of ferrous sulphate as an antiseptic and germicide. By Allan J. McLaughlin.

*No. 16.—The antiseptic and germicidal properties of glycerin. By M. J. Rosenau.

*No. 17.—Illustrated key to the trematode parasites of man. By Ch. Wardell Stiles.

*No. 18.—An account of the tapeworms of the genus *Hymenolepis* parasitic in man, including reports of several new cases of the dwarf tapeworm (*H. nana*) in the United States. By Brayton H. Ransom.

*No. 19.—A method for inoculating animals with precise amounts. By M. J. Rosenau.

*No. 20.—A zoological investigation into the cause, transmission, and source of Rocky Mountain "spotted fever." By Ch. Wardell Stiles.

*No. 21.—The immunity unit for standardizing diphtheria antitoxin (based on Ehrlich's normal serum). Official standard prepared under the act approved July 1, 1902. By M. J. Rosenau.

*No. 22.—Chloride of zinc as a deodorant, antiseptic, and germicide. By T. B. McClintic.

*No. 23.—Changes in the Pharmacopœia of the United States of America. Eighth Decennial Revision. By Reid Hunt and Murray Galt Motter.

No. 24.—The International Code of Zoological Nomenclature as applied to medicine. By Ch. Wardell Stiles.

*No. 25.—Illustrated key to the cestode parasites of man. By Ch. Wardell Stiles.

*No. 26.—On the stability of the oxidases and their conduct toward various reagents. The conduct of phenolphthalein in the animal organism. A test for saccharin, and a simple method of distinguishing between cumarin and vanillin. The toxicity of ozone and other oxidizing agents to lipase. The influence of chemical constitution on the lipolytic hydrolysis of ethereal salts. By J. H. Kastle.

*No. 27.—The limitations of formaldehyde gas as a disinfectant with special reference to car sanitation. By Thomas B. McClintic.

*No. 28.—A statistical study of the prevalence of intestinal worms in man. By Ch. Wardell Stiles and Philip E. Garrison.

*No. 29.—A study of the cause of sudden death following the injection of horse serum. By M. J. Rosenau and John F. Anderson.

†No. 30.—I. Maternal transmission of immunity to diphtheria toxine. II. Maternal transmission of immunity to diphtheria toxine and hypersusceptibility to horse serum in the same animal. By John F. Anderson.

†No. 31.—Variations in the peroxidase activity of the blood in health and disease. By Joseph H. Kastle and Harold L. Amoss.

†No. 32.—A stomach lesion in guinea pigs caused by diphtheria toxine and its bearing upon experimental gastric ulcer. By M. J. Rosenau and John F. Anderson.

*No. 33.—Studies in experimental alcoholism. By Reid Hunt.

†No. 34.—I. *Agamofilaria georgiana* n. sp., an apparently new roundworm parasite from the ankle of a negress. II. The zoological characters of the roundworm genus *Filaria* Mueller, 1787. III. Three new American cases of infection of man with horse-hair worms (species *Paragordius varius*), with summary of all cases reported to date. By Ch. Wardell Stiles.

†No. 35.—Report on the origin and prevalence of typhoid fever in the District of Columbia. By M. J. Rosenau, L. L. Lumsden, and Joseph H. Kastle. (Including articles contributed by Ch. Wardell Stiles, Joseph Goldberger, and A. M. Stimson.)

†No. 36.—Further studies upon hypersusceptibility and immunity. By M. J. Rosenau and John F. Anderson.

†No. 37.—Index-catalogue of medical and veterinary zoology. Subjects: Trematoda and trematode diseases. By Ch. Wardell Stiles and Albert Hassall.

No. 38.—The influence of antitoxin upon post-diphtheritic paralysis. By M. J. Rosenau and John F. Anderson.

†No. 39.—The antiseptic and germicidal properties of solutions of formaldehyde and their action upon toxines. By John F. Anderson.

†No. 40.—1. The occurrence of a proliferating cestode larva (*Sparganum proliferum*) in man in Florida, by Ch. Wardell Stiles. 2. A reexamination of the type specimen of *Filaria restiformis* Leidy, 1880=*Agamomermis restiformis*, by Ch. Wardell Stiles. 3. Observations on two new parasitic trematode worms: *Homalogaster philippinensis* n. sp., *Agamodistomum nanus* n. sp., by Ch. Wardell Stiles and Joseph Goldberger. 4. A reexamination of the original specimen of *Tœnia saginata abietina* (Weinland, 1858), by Ch. Wardell Stiles and Joseph Goldberger.

†No. 41.—Milk and its relation to the public health. By various authors.

†No. 42.—The thermal death points of pathogenic micro-organisms in milk. By M. J. Rosenau.

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†No. 43.—The standardization of tetanus antitoxin (an American unit established under authority of the act of July 1, 1902). By M. J. Rosenau and John F. Anderson.

No. 44.—Report No. 2 on the origin and prevalence of typhoid fever in the District of Columbia, 1907. By M. J. Rosenau, L. L. Lumsden, and Joseph H. Kastle.

†No. 45.—Further studies upon anaphylaxis. By M. J. Rosenau and John F. Anderson.

No. 46.—*Hepatozoon perniciosum* (n. g., n. sp.); a hæmogregarine pathogenic for white rats; with a description of the sexual cycle in the intermediate host, a mite (*lelaps echidnimus*). By W. W. Miller.

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No. 77.—Sewage pollution of interstate and international waters with special reference to the spread of typhoid fever. By Allan J. McLaughlin.

No. 78.—Report No. 4 on the origin and prevalence of typhoid fever in the District of Columbia (1909). By L. L. Lumsden and John F. Anderson. (Including articles contributed by Thomas B. McClintic and Wade H. Frost.)

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